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The Mining Magazine

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CONTENTS.

EDITORIAL

WE have pleasure in announcing that Mr. J. A. L. Gallard has joined the editorial staff of the Magazine as associate editor. Mr. Gallard has for the last seventeen years been mining editor of *The Financial Times*, and requires no introduction to our readers as an authority on mining finance.

STEPS are to be taken by the Institution of Civil Engineers to obtain Parliamentary sanction to a change in its constitution whereby it will be able to exercise control over the use of the term "civil engineer." It is to be hoped that the collateral scheme of the four mining and metallurgical societies for the formation of a register of mining engineers will be pushed forward at the same time.

IN the New Year's Honours List are the names of Mr. Robert Taylor, Mr. J. T. Cargill, and Mr. E. Mackay Edgar. Mr. Taylor's knighthood marks the appreciation on the part of the Indian Government of Messrs. John Taylor & Sons' work for the mining industry of that dependency. Mr. Cargill is chairman of the Burma Oil Company, and a director of the Anglo-Persian. To mining engineers Mr. E. Mackay Edgar is chiefly known for his participation in the finance of the Urquhart Siberian group.

DISAPPOINTMENT is freely expressed at the lukewarm reception by Mr. A. J. Balfour, in his capacity of Lord President of the Council, of the deputation from the Imperial College of Science and Technology, which addressed a memorial to him praying for the reconstitution of the College as a University competent to grant degrees. The battle between the College and London University has broken out openly once more, but we feel confident that Mr. Balfour will find some way out of the present apparent impasse that will prove acceptable to the College.

A NEW company, called the Francois Cementation Co., Ltd., has been formed as a subsidiary of the Chemical and Metallurgical Corporation to work the process of Monsieur A. J. Francois for preventing the inflow of water into mines by injecting cement under pressure. The directors of the new company include Messrs. F. W. Baker, J. A. Agnew, H. F. Marriott, A. Stanley Elmore, H. N. Berry, and the inventor. The last two represent coal-mining experience, while the others are of course well known in the world of metalliferous mining. We published an illustrated article on the process, as adapted to Rand practice, in the issue of August, 1918.

THE Royal Statistical Society has addressed a memorial to the Prime Minister urging the improvement of Government statistics. Last year we drew attention to the incomplete and unsatisfactory nature of the returns of exports and imports and of the outputs of the mines. The Society's interests are of course far wider, but their report shows that in all Government departments the same ineffectiveness of the official labours in connection with statistics prevails.

AMONG the Reviews of New Books in the current issue will be found one of unusual interest, written by Mr. J. D. Kendall, criticizing the Memoir of the Geological Survey on the Iron Ores of Cumberland and North Lancashire. Mr. Kendall's knowledge of Cumberland iron-ore deposits is unrivalled, and his book, "The Iron Ores of Great Britain," though written twenty-six years ago, is still the acknowledged authority. His controversy in days gone by with the Geological Survey will be remembered by some of our older readers; with regard to this episode we may remark that, though his views of the geology were eventually adopted, he never received any public credit. Under these circumstances, it is not surprising that in his review of the new Memoir he handles the author and the Survey without gloves.

The Origin of Petroleum.

Ever since petroleum became an important article of commerce, geology has been applied to its discovery, and naturally its origin, possible migration, and method of accumulation have formed important features in the discussions and investigations. As regards the origin, the various theories cover a wide range of possibilities. In this issue, Mr. I. A. Stigand contributes an important paper on the subject. He reviews the many suggestions that have been proffered, and he adduces evidence based on personal observation. Mr. Stigand is an oil geologist of wide experience in many parts of the world, and he is also a keen student of the literature, as is evidenced by his full references. His general view of the subject is that most if not all the theories put forward are tenable in so far as they explain some process whereby petroleum can be formed, for as a rule it is impossible to bring absolutely contradictory evidence forward. He considers, therefore, the battle of the theories to consist of a discussion of their relative likelihoods from the point of view of generating large commercial supplies. He begins by briefly examining the inorganic theory, and shows that hydrocarbons of a similar nature to those contained in petroleum can be produced by reactions between inorganic substances, but he does not believe that any important amounts could be formed in this way nor could they be preserved for any great length of time. The main part of the paper consists of a more detailed examination of the possible organic origins. Here the author gives it as his view that marine organic sources are the most important, and in particular considers the small forms of organisms, both animal and vegetable, which exist in such abundance and multiply so rapidly, as the source of the largest accumulations of oil. In connection with this mode of origin, he gives instances of the personal observations to which reference has been made. The nature of the occurrences in Borneo described by him is such as to provide direct evidence of marine organic origin. Another item in the discussion is the relationship of salinity to the occurrence of petroleum. The author considers salinity to indicate a general prevalence of desiccated conditions attending deposition, although he points out that a saline condition of the water would tend to promote the separation of the oil and thus the production of accumulations. As regards accumulations, the view is taken that petroleum is seldom indigenous to the beds in which it is formed, in this way contesting the opinion of Höfer. Mr. Stigand presents the view that rapid argillaceous sedimentation is a favourable condition for accumulation, and that among the several factors required is the presence of a rock suitable as a medium, permitting the movement of the oil from the seat of origin by means of capillarity, adsorption, or the presence of cracks and fissures in the argillaceous material, whereby the bitumen can reach and accumulate in the porous beds. In conclusion, the author regards bitumen as not of sporadic or restricted occurrence, but as being fairly generally present throughout the rocks, only becoming conspicuously present or accumulating in appreciable deposits where the various conditionary factors discussed are available.

Spitsbergen.

Brief mention was made last month to the collapse of what an Irishman would call the iron bubble of Spitsbergen. Owing to the report of the Northern Exploration Company being published just as we were going to press no extended notice of it could then be given, and it was necessary to postpone further comment until the present issue.

Of the various mineral deposits described by the company, that of magnetite was held to be of prime importance. The coal seams have been known for many years, and particulars have been given in this Magazine and elsewhere, so that argument relating to them has been unnecessary. The richness of the iron ore deposit at Recherche Bay was vouched for only by the company and no account of it had ever been published by an acknowledged authority. At the time we printed Mr. Marstrander's letters we had in our possession reports made by well-known iron experts for substantial business houses, and we had private knowledge of the results of examinations made by a number of other engineers. These reports unanimously agreed that the iron ore deposits were of no commercial value. The Northern Exploration Company had, however, been all along a firm believer in the iron ore deposits, as may be seen from the following quotations from their pamphlet: "It is estimated that there are many millions of tons of very rich ore in mountainous formation. The mountains are some 2,000 ft. in height and stretch southward for about 17 miles. It is indeed doubtful whether these deposits can be paralleled." This summer the disillusionment arrived, after an examination made for the company by Mr. C. W. Boise. The report of the company's consulting engineer, Mr. William Selkirk, was issued just before we went to press with the December issue, and, as already mentioned, there was no opportunity to deal with the matter at any length. And as a matter of fact Mr. Selkirk's remarks on the deposit are as brief as the short paragraph we were able to insert. He says: "The iron deposits at Recherche Bay were carefully examined, and I do not think they are of economic importance." At the meeting of shareholders, which was held shortly afterwards, the Chairman handled the subject in a highly judicious manner, laying little stress on the iron position and omitting to mention the high hopes centring on the deposit. He expatiated at considerable length on the coal and marble deposits, and quoted the engineers' accounts of occurrences of graphite, asbestos, zinc, silver, and gold.

He concluded by moving a resolution to double the capital of the company by the creation of 500,000 new shares of £1 each. The shareholders agreed to this course, and to the continuance of prospecting and development throughout the concessions. No announcement has as yet been made with regard to the issue of these shares. The future of the company will depend on the availability of further funds, but the glamour has gone with the failure of the Recherche Bay iron deposits, and it is impossible for shareholders to become wildly enthusiastic with regard to the other prospects described in Mr. Selkirk's report. The whole incident of the Northern Exploration Company and its iron ores forms another example of the disasters attending a refusal to accept expert mining advice. Among the directors and shareholders are several men of substance who have been highly successful in many lines of business, and it is remarkable that they should have made the hoary mistake of investing their money without first obtaining skilled advice.

New Sources of Power.

The questions involved in the discussions as to future sources of power are in a way allied to the functions of a mining engineer, seeing that the products of the earth made available to the service of man by his labours form the ultimate basis of the problems, and the exhaustion of such products gives the cause of investigation into new sources. Coal and petroleum will not last indefinitely, nor is it advisable that their consumption should be too intense, otherwise the carbonic acid and carbonic oxide contents of the atmosphere will become too great for the endurance of the human frame. Hydro-electric power has come to the fore, but in this country opposition is powerful, and numerous possible schemes are nipped in the bud, or are denounced roundly. An example of this antagonism is provided by the Dartmoor project, where objection is raised to the impounding of the waters of the streams coursing down the slopes of the land of tors and bogs, and their use in generating current for an electrolytic copper refinery. Communications in the press inveigh against the corruption of heaven's air in one of nature's beauty spots, but one would more gladly see a reference to public thankfulness to the engineer who can create a useful industry without fouling the atmosphere, an attitude that would be more appropriate in this connection. Hydro-electric energy was one of the wonders of the world thirty years ago, but is already 'staled by frequence, shrunk by usage, into commonest commonplace," and the physicists are beginning to predict other sources of energy as yet unapplied, or even unknown. Reference has already been made in these pages to Sir Charles Parsons' proposals to tap the heat of the interior of the earth, and to the installations in Italy which utilize volcanic steam. During the past month attention has once more been drawn by Sir Oliver Lodge, in a lecture before the Royal Society of Arts, to atomic energy, and Mr. A. A. Campbell Swinton has, in the columns of *Nature*, pointed out the possibility of converting the sun's rays directly into electric current.

The researches in connection with radioactivity have proved that atoms break up, and in so doing evolve an amount of energy enormous in comparison with their size. Radioactive elements periodically fire off projectiles with more than volcanic violence. A radium atom emits five projectiles consisting each of a particle of helium, and then settles down as a substance chemically indistinguishable from lead, and assumes a much quieter form of existence thereafter. It is deduced from these known facts that all substances possess atomic energy in a descending or ascending scale. This must not be confused with molecular energy which is exhibited by the evolution or absorption of heat when the atoms are re-arranged. At the present time no method is known of utilizing atomic energy, and it is not easy to imagine a method of forming an integral of the vast series of minute forces. When the method is found it will be necessary to confine the integration between severe limits; otherwise the world will be blown to pieces in less than no time.

Mr. Campbell Swinton points out that the sun's energy arriving on the earth in these latitudes may be reckoned at 1,000 horse-power per acre during the hours of daylight, but that hitherto all attempts to harness the sun's rays have been confined to the evaporation of water through the instrumentality of a series of converging mirrors. He suggests that the electromagnetic waves of the ether which convey the sun's energy should be converted directly into continuous current, employing an apparatus similar to the ionic valve used in wireless telegraphy and telephony. This ionic valve is one of the most wonderful inventions of the age, but, owing to the recondite nature of the science of wireless telegraphy, it is little more than a mysterious name to the average man. To put it briefly, magnetic waves are of the alternating or oscillating type, and the ionic valve is an instrument which stops the back oscillation but allows the forward oscillation to proceed. Thus rapidly pulsating unidirectional currents are obtained, which behave like continuous currents. The length of the sun's wave is far smaller than that of the wireless telegraphy wave, so that the nature of the valve required would of course be different. There is no inherent reason, however, why the method should not be applied to obtaining continuous currents from the sun's rays. Mr. Campbell Swinton's suggestion is one that may be of far-reaching importance. Investigation along these lines seems to be more promising than that in connection with atomic energy, and, if successful, the power obtained would not be in so dangerous a form.

More Reminiscences.

The thanks of the profession are due to Mr. E. T. McCarthy for having provided appropriate Christmas reading by the publication of a second volume of "Incidents in the Life of a Mining Engineer." It is well occasionally to escape from the dry bones of technical science and the selfish chaffering of Throgmorton Street, and to look at the mining engineer's life from the human side, particularly when the human side is presented to us by a man of upright principle and aggressive fearlessness, in fact by a muscular Christian and man of the world. The book is in parts humorous and in parts pathetic, and always instructive, and over all there is a subtle influence for good.

Mr. McCarthy's life has been a long and busy one, and his experiences have been spread over a great many parts of the world. When reviewing his first volume more than a year ago, we mentioned that his early travels had taken him successively to the United States, West Africa, Morocco, Canada, Nicaragua, Malaya, China, Australia, New Zealand, Uruguay, and the North-eastern Transvaal. The second volume begins in southern Mexico, and takes us subsequently to Swaziland, China, Malaya, Borneo, Corea, Siberia, Japan, northern Mexico, Siam, and Canada. These journeys were not by any means in the nature of flying visits, but were generally sufficiently extended to give him a pretty shrewd idea of the actual conditions of life of the inhabitants and their mental bent. The depth of his racial knowledge is most characteristically exhibited in connection with China and Corea. His insight into men and affairs indicates that if he had not had such strong calls for his services as a mining engineer he would surely have found his métier as a Colonial Governor.

Within the small space available it is difficult to give as many quotations from the book as we should like, and the references must necessarily be haphazard and brief. His adventures on the coasting steamer in the Gulf of Mexico were unenviable. Here he was cooped up for three days in a corner of an unsheltered deck, surrounded by a cargo of hay and by crowds of peons perspiring garlic, with no sustenance but a few bottles of beer and a tin of biscuits. Afterwards he is found on mule-back doing several miles along the brink of a precipice, and he recounts how a mule laden with hydrochloric acid on one side and ammonia on the other fell and cracked the demijohns, the resulting clouds of sal-ammoniac scaring the natives into the belief that it was a case of spontaneous combustion. His account of the Palenque ruins is instructive. These are on the scale of the Egyptian remains of former civilizations, such as the Pyramids, and the Temple of Philæ, while the proportions of the sculptures must have equalled those of the ancient Greeks. Yet there is no historical record of these buildings and monuments, and no key to the inscriptions has been discovered. Seeing that the district is far from being a health resort, it is not popular with antiquaries, so a systematic study of the ruins is not likely to be undertaken.

Mr. McCarthy's account of his stay at Pigg's Peak, Swaziland, is of special interest because it describes the premonitory rumblings of the Boer war, and the deportation of foreigners on its outbreak. He had the misfortune to have as governess in his family a lady of Dutch extraction who acted as a spy, secretly despatching information to Pretoria as to conditions in the district, and it was only on the exodus of the English that she showed her hand. Mr. McCarthy was one of the few who expected the war and that immediately, and, in spite of chaff, some of it insulting enough, took the community in bullock wagons to Portuguese territory, reaching Lorenzo Marquez in time to see the hapless plight of the refugees arriving by train. Among the incidents during his residence at Pigg's Peak that raise a laugh, though it was no laughing matter at the time, was his being marooned for hours in the middle of a span of the aerial ropeway, owing to the native operator at the top fleeing for his life on seeing him coming up in a bucket.

After leaving Africa, Mr. McCarthy went once more to the East, and spent many years in China and Corea, going from time to time also to Malaya and the East Indies. With regard to steamer accommodation to the East he takes the opportunity of voicing the general grievance which passengers have against the Peninsular and Oriental Company, and points contrastingly to the methods of the German shipping people, to whom was deputed that section of Teutonic policy depending on politeness intended for capturing the trade of the world. At Amoy occurred one of those unfortunate incidents that occasionally occur when the truth is bluntly spoken. Mr. McCarthy had examined a concession belonging to a British resident there, and reported that the price his client was demanding was far too high for an unproved mineral concession. Before many days had gone by, the client shot himself, without ever having attempted to argue or expostulate, and subsequently his affairs were found to be in a hopeless tangle. He had hoped by this projected mining coup to have straightened out his finances, and his disappointment was keen. His future depended on the nature of Mr. McCarthy's report, but that report, as those who know Mr. McCarthy may guess, would not in any way have been modified had he had any premonitory suspicions of the impending tragedy.

Shortly afterwards Mr. McCarthy had another kind of experience in connection with an adverse report. He had been asked to examine the Raub gold mine in Pahang, which was operated by an Australian company with an office at Singapore. The mine had paid well when worked on a small scale with twenty stamps, and the directors had been encouraged to expand the scale of operations and build an 80-stamp mill. On Mr. McCarthy's arrival he found that no assay-plans were kept and that the management had little idea of the value of the ore developed. He had first to make a plan of the mine and then to sample it. The result showed that, though there was a fair amount of rich ore suitable for treatment in the old mill, the rest of the ore was of low grade, and consequently the new policy of expansion was not sound. The board were completely taken by surprise, and deemed it best to obtain a second opinion, which, however, put an even worse complexion on the prospects. The unfortunate part of the incident was that local opinion in Singapore was much against Mr. McCarthy. He was cold-shouldered at the Club, and the Singapore papers published many abusive communications with regard to him, alleging that he was a bear agent and, alternatively, that he was a thoroughly incompetent mining engineer.

Mr. McCarthy's account of life and conditions in the East Indies and the Malay reaches a high level of word painting. He was not able to arouse any enthusiasm within himself for the ourang-outang on account of its extreme ugliness, but on the other hand was charmed with the sportive and intelligent demeanour of the elephant. His collection of orchids acquired in Borneo was lost in transit to England, the packing case arriving empty. The theft was obviously one of the activities of the international gang who deal in jewels, furs, and such-like valuables. The story of the Dyak boat gives further evidence of the trust he inspired among native races. During his stay at Pontianac, in Borneo, his evening constitutional consisted of marching sentry-wise, crossing and re-crossing the equator. This feat he performed times without number, and he could ever thereafter confidently affirm to any ship's captain that he had crossed the equator more times than he.

The chapters devoted to Corea are perhaps the most valuable in the book, for they give information about a country that is little known in the West, and the information is not confined to the local conditions and problems, but deals also with the influence exerted by the surrounding countries and races. Considerable space is devoted to the early history of the Hermit Nation, and this, together with experience derived from long residence, forms much interesting and instructive reading. His tribute to the excellent pioneer work done by Mr. Henry Collbran deserves more than passing notice. Mr. Collbran built the first electric railway and electric light installation in Corea, and these events were epoch-making in the advance of the country. Later, Mr. Collbran acquired the Suan gold mines and made a huge success of them. He has also opened a large copper mine, which the Japanese have recently acquired from him. Mr. McCarthy says of Mr. Collbran that he more than anyone else led the industrial development of Corea.

We have no space left for reference to the chapters devoted to Siberian copper mines, Palmarejo, and Porcupine, and we must leave readers to sample them on their own. Before concluding, however, there is one more subject to mention, without which no notice would be complete. Every one, especially those who have lost young children in a tragic manner, will feel their hearts warmed to Mr. McCarthy when reading of the dreadful accident to his young son and of the alarmingly sudden death of his little daughter. Such incidents, though hard enough to bear, afford a true test of the innate goodness of human nature.

REVIEW OF MINING

Introduction.—The feature of the market since Christmas has been a wild speculation in metals. The increased buying has not come from consumers, but from outsiders who, legitimately enough, expect a permanent rise in prices. The buying is, however, overdone, and the present high levels will experience a set-back. The Russian position is becoming worse again, and the forces representing law and order are being driven back by the Bolshevists. The Mexican Government is once more seeking recognition in financial and commercial circles here, and hopes are raised that conditions in that country will improve.

Transvaal.—Thanks almost entirely to the gold premium, the Rand dividend record for 1919 makes a much better showing than at one time seemed probable. In sundry instances, Crown Mines being a notable example, production has also been augmented, but the labour shortage has had the effect in several other cases of restricting output to some extent. The total distribution for 1919 was £6,287,200, as compared with £5,330,000 in 1918, and £6,556,000 in 1917. It is not possible to publish the usual table giving particulars of distributions during 1919 and 1918, owing to the individual figures from several companies not having yet arrived. Springs Mines, which entered the dividend list in 1918, has not rewarded its shareholders with any distribution for the year just ended, for the reason mentioned hereafter, but the New Modderfontein has established a fresh dividend record, and other companies operating in the Far East Rand have also increased their distributions. The re-entry into the dividend list of old and dying mines of the central Rand is also a pleasing feature.

The native labour contingent at the gold mines was further reduced in November, the figures at the end of the month being 164,671, as compared with 167,499 at the end of October, and 175,620 at the end of March, when the supply was at its best. The gold output dropped in November to 677,970 oz. The December figures were not available when we went to press, but it is evident that unless these show a substantial recovery the total for 1919 will not be quite equal to that for 1918, when the output was 8,420,659 oz. The market value of the year's production, however, will be higher on account of the much better price the metal has been realizing since the freeing of the gold market in July.

The gold premium has made a considerable difference already to the financial results of the producing mines, and has more than counterbalanced the increase in the miners' phthisis tax. But it is not an unmixed blessing. Some months ago the white employees of the Rand mines put in a claim for increased wages and reduced working hours, and the fact that the revenue of their employers has been and is still being augmented by the higher price ruling for the precious metal is hardly likely to make the men inclined to modify their demands. The Transvaal Chamber of Mines has made a counter proposal with the object of meeting the men's demand for increased pay on account of the enhanced cost of living, but it remains to be seen whether this offer will have the desired effect of settling the matter in a manner satisfactory to both parties. Were the present gold premium a fixture, the controllers of the mines, or at any rate most of them, might be willing to accede to the men's demands rather than run the risk of a strike and a stoppage of production; but, of course, it is uncertain for what length of time and at what rate the gold premium, which has been fluctuating almost daily, will be maintained. This uncertainty should be, if it has not already been, made clear to the employees concerned.

The directors of Springs Mines have decided to make no distribution of dividend for the second half of 1919, but to appropriate from the profit earned the amount required to liquidate the excess expenditure on the original equipment of the property. The profit undivided at the end of December was estimated at £413,390, and the excess expenditure at £349,272.

A strike among white miners occurred last month at the Simmer Deep and Jupiter, the cause being the disinclination of the men to have a German in their midst. A ballot showed the men to be overwhelmingly against the presence of the German, and the matter was soon settled satisfactorily.

The latest progress report relating to the reorganization work at Randfontein Central is to the effect that the West Reef has been struck in the North shaft at a depth of 3,560 ft., where the dip is 60°. The average assay-value of seven complete sections was 11·1 dwt. over 48 inches.

The shares of the Rand Mines, Ltd., are being introduced on the New York Stock Exchange by arrangement between the Central Mining

& Investment Corporation and Messrs. Bernhard Scholle & Co. It may be presumed that the Far East Rand holdings of the Anglo-American Corporation of South Africa will make their appearance in New York before long, and it is stated that De Beers shares are to be listed there shortly.

Arrangements have been concluded for the splitting of New Modderfontein £4 shares into eight of 10s. each, and market quotations are now on that basis.

The report of the Messina company for the year ended June 30 last shows that 117,163 tons of copper ore was raised. By hand-picking, 190 tons averaging 54% copper was collected, and, by the smelting of concentrate, 4,549 tons of matte averaging 59% was produced. These products were shipped for sale. The result of the year's work was a loss of £39,373. The proved reserve is estimated at 104,547 tons averaging 4·28%, the probable ore 82,274 tons averaging 3·41%, and the possible ore 228,768 tons averaging 2·73%. New milling plant is being installed, and a subsidiary company is to be formed for the purpose of providing a smelter and refinery.

Agents of German cyanide manufacturers have been endeavouring to resume business relations with the gold-mining companies they supplied before the war. They are not finding it at all an easy matter, however, for the reason that most of, if not all, the British owned mines which were producing before the war are bound by their contracts to buy of British manufacturers for five years from the official end of the war.

Rhodesia.—The output of gold during November was reported at £186,462, par value, as compared with £204,184 in October. Other outputs in Southern Rhodesia were: silver 15,332 oz., coal 45,450 tons, copper 257 tons, asbestos 978 tons, diamonds 40 carats, arsenic 38 tons, mica 2 tons.

Labour troubles among the white workmen employed by the Gold Fields Rhodesian group have given rise to much anxiety for the future of the mines. In particular the Shamva, Gaika, and Falcon have been affected. At Rezende the white workers went out on strike, but operations were continued with 30 stamps with the staff and natives. The Wankie Colliery was also affected. The strike at the gold mines was settled by the men being given 20% increase in wages and a 48-hour week. The Globe & Phœnix has had to suspend mining operations owing to the shortage of coal supplies.

The report of the Eldorado Banket now to hand is the last to be made, for mining was stopped at the end of July, and the machinery has been sold. This mine was one of the best in Rhodesia, and contained some very rich ore. The word "banket" was really a misnomer, for the gold was found in an unusual schistose conglomerate having no hanging wall but a most distinct foot-wall. The ore-body was in the form of a chimney, the depth being twenty times the length.

West Africa.—As reported last month, the October output of Ashanti Goldfields was much below normal on account of shortage and inefficiency of labour. Since then the financial result for the month showed a loss of £563, taking gold at par. This is quite an unusual occurrence at this company's mines. However, as the gold output for October will realize £5,700 above par, the temporary depression will be compensated in some degree. The results for November showed an increase in output, but still below normal. It is pleasant to record that developments at the Abosso have been most successful recently and that the company has been able to resume the payment of dividends.

With regard to labour shortage, some of this is caused by the scarcity of coin and the disinclination of the natives to accept paper money. A Government report just issued refers to this subject at some length. The hoarding of silver coin is prevalent to an extent disconcerting to the authorities, who are not able to supply metallic currency in the quantities required. In addition to 10s. and 20s. notes, others of the denomination of 1s. and 2s. have been issued, and there seems no alternative but for the native to conquer his aversion to this class of currency.

Nigeria.—The directors of the Ropp Tin Company have proposed, and the shareholders have agreed, that part of the share-premium account shall be capitalized. The company has been highly successful in its dredging operations, and 955 tons of tin concentrate was produced during the first eleven months of 1919, against 774 tons during the corresponding period of 1918. The capitalization has always been low, and the shares stand at a high premium, so that when new shares were issued they were offered at considerably more than par value. Of the share-premium account, £100,800 is to be capitalized, and 504,000 new shares of 4s. each par value are to be distributed as a bonus, at the rate of 1½ shares to each one at present held.

Australasia.—The strike at Broken Hill continues, but that at Kalgoorlie has collapsed and the men have gone back on the same terms as before. The drought in northern Victoria and the adjoining parts of New South Wales has been broken, though not before irreparable losses had been suffered by farmers and settlers.

The agitation for a State smelter for base metals in West Australia having blown over, the price of lead having risen, and the freights to this country having been reduced, the Fremantle Trading Company has been encouraged to recommence mining and smelting, and to propose a considerable extension of the scale of operations. The company's mines in Northampton district have been unwatered, and it is hoped to start in February. The new programme comprises the erection of modern plant for the treatment of copper and other ores as well as those of lead, and generally to cater for all metals throughout the State except gold. For the purpose of providing the necessary funds for the expansion, additional shares are to be offered for subscription.

Lake View & Oroya Exploration is to be reconstituted as a "trust investment" company, instead of a "financial" company. The difference between these two classes of companies is that in the former case the profits made by realization of assets are not subject to taxation. Companies of the latter type such as the one now mentioned are hit hard by income tax and excess profits duty, and are not able to fully realize the profits due to them by the appreciation in the value of many of their investments, in this case, for instance, Burma Corporation shares. It is proposed at the same time to change the name of the company to the Lake View Trust.

The Mount Elliott group of copper mines in Queensland have been idle for some time owing to difficulties of shipment and labour. The directors feel that the time has come when the properties must be worked on a large scale and the ore of all grades mined, instead of, as in the past, using only the high-grade direct-smelting ores. For this reason they have given an option to Hayden, Stone & Co., of Boston, a firm intimately associated with large low-grade copper properties such as the "porphyries." In the Mining Digest this month we publish an illustrated description of the Mount Oxide mine, which is controlled by the Mount Elliott company.

During the half-year ended November 30, the output of copper at Mount Morgan was 2,749 tons and of gold 41,191 oz., and a dividend of £50,000 was paid. The amount of ore raised was 146,181 tons, and the smelter treated 57,238 tons of ore and 27,804 tons of concentrates. A leaching plant with a capacity of 10 tons per day is being erected.

Last June we mentioned that owing to the closing of the Irvinebank tin smelter many small mines had nearly come to grief, and that the Government had come to the rescue by advancing £100 per ton on concentrates. News is now to hand that the Government has since gone further, and has purchased the dressing plant and smelter from the executors of the late owner, for the sum of £22,500. It is intended to operate 15 or 20 stamps as a State battery, and to smelt the concentrates produced, together with other concentrates received from farther north.

A further instalment of working capital is required by the Electrolytic Zinc Co. of Australia for the extension of the works at Risdon, Tasmania, and additional shares will be subscribed by the North and South Broken Hill companies, the Amalgamated Zinc, and the Zinc Corporation. The capital so far issued is £500,000, and the scheme calls for an ultimate expenditure of £1,500,000.

The Tasmanian Parliament has sanctioned the Lake Rolleston hydro-electric power scheme, and £500,000 is to be spent on it. The power is to be supplied to the Mount Read & Rosebery group of mines, now controlled by the Mount Lyell company, chiefly for electro-metallurgical purposes. The contract calls for the supply of 15,000 h.p. for 15 years at a charge of 55s. per horse-power-year. The Mount Read & Rosebery company has recently purchased the works of the Tasmanian Smelting Company at Zeehan, where an electrolytic zinc plant is to be erected.

Malaya.—The Kamunting Tin Dredging Co. is acquiring additional properties, and two new dredges are to be built. To provide the necessary capital, 130,000 new shares of £1 each are being offered for subscription at 30s.

Burma.—The Indian company to acquire the Bawdwin mines was registered at Rangoon on December 17. Particulars of the objects and capitalization have already been given in these columns.

Cornwall.—The acquirement of control of the Levant by Mr. Oliver Wethered is discussed by our Camborne correspondent elsewhere in this issue. We need say no more here, except to record the fact that this is the second important occasion when Mr. Wethered has come to the rescue of a famous Cornish mine, the other case being, of course, Dolcoath in the year 1895.

Prospects for Grenville have distinctly improved owing to the election to the board of

Mr. H. G. Payne and the appointment of Mr. Josiah Paull as consulting engineer.

The success of the East Pool flotation plant has encouraged a revival of experiments on tin ores. A Minerals Separation plant with a capacity of 30 tons per day has been installed at South Crofty for experimental purposes.

According to the *Cornish Post*, Major Bullen is extending his activities beyond lode mining, and has turned his attention to alluvial deposits. The *Post's* account of the riches of the Calloose deposits is as florid as its story of the Trevascus venture, and it leaves us equally cold.

Some months ago it was mentioned in the Magazine that the Treburgett silver-lead mine at St. Teath was to be reopened. This is a very old mine that has been worked now and again for short periods. The prospectus was advertised last month, when 40,000 shares of 5s. were offered at par. The consulting engineer, Dr. J. B. Garbe, is not a member of the Institution of Mining and Metallurgy, and we do not know the meaning of the initials after his name, A.M.G.C.M., so that his professional status is not clear.

Wales.—The old Clogau copper-gold mine, near Dolgelly, is once more attracting attention, for it is announced in the press that visible gold has been struck. This deposit has been worked for gold on many occasions, the first being in 1860, and the rich pockets have proved incentives to exploration to successive workers. Readers will remember the operations of the Pritchard-Morgan company, and more recently those of Mr. Godfrey Isaacs' company, the St. David's Gold & Copper Mines, Ltd. The latter company did quite well for a time, producing altogether 52,000 oz. of gold and paying 65% in dividends, but eventually the rich patches failed and work was stopped. There is no reason why some more of these little bonanzas should not be found.

Oil in England.—At the meeting of the English Oilfields, Ltd., Dr. Forbes Leslie gave a lengthy account of the progress of the treatment plant now being erected to deal with the Norfolk oil-shales. At the Derbyshire oil wells, conditions are still uncertain and things are going slow. The Hardstoft bore is the only one yielding oil. The flow is slow and no pumping is being done. An oil exhibition is to form part of the Great War Show to be opened at the Crystal Palace in May.

United States.—The annual meeting of the Camp Bird shareholders held last month was as usual an event of great interest among mining engineers. The deep-level workings at the Camp Bird mine have not yet developed any large amount of high-grade ore, though six months ago, as recorded by us at the time, the results were such as to give good grounds for expecting immediate important developments. Most of the work now being done has for its object the provision of necessary ventilation between the old mine and the tunnel. The progress of the subsidiary company, Santa Gertrudis, is uninterrupted. The output of silver is normal, and new supplies of ore from the new properties, particularly El Bordo, will be coming forward shortly. The company also has substantial holdings in the recently formed Mexican Corporation and the National Mining Corporation.

Colombia.—The progress of the British Platinum & Gold Corporation has been rapid for these days. It has now been decided to amalgamate the corporation and the Paris (Transvaal) Gold Mines, Ltd., in order to simplify business operations in Colombia. The two companies owned equal shares in the properties, and a consolidation, now that the transaction has been carried through successfully, is only logical. A meeting was held last month to approve the proposal to create new capital of the corporation and to allot new shares to shareholders in the Paris (Transvaal) company.

While writing of dredging in Colombia, it is appropriate to mention that the other English company operating there, the Anglo-Colombian Development Co., a member of the Consolidated Gold Fields group, has been absorbed by the South American Gold & Platinum Co. of New York, which is controlled by the Lewissohns. The properties of this company are in the same district as those of the British Platinum & Gold Corporation, namely, on the Condoto and San Juan rivers, in the Choco province.

Spitsbergen.—We refer on another page to the report and meeting of the Northern Exploration Company. As regards the Scottish Spitsbergen Syndicate, steps are now being taken to form a subsidiary company to develop the coal deposits at Adolf Bay. The Syndicate also points out that one of the Norwegian companies working coal in Spitsbergen, the Norwegian Spitsbergen Coal Company, has issued a satisfactory report, paying 7% dividend on a capital of £500,000 on an output of 50,000 tons, and placing a similar amount to reserve. This coal was delivered in eighty trips, and sold in the northern districts of Norway, and to the State railways, to the Navy, and to steamship companies.

THE ORIGIN OF PETROLEUM

By I. A. STIGAND, M.A., F.G.S.

The author reviews the various theories that have been put forward to explain the origin of petroleum. He lays particular stress on the marine organic sources of origin, especially the small forms of organism both animal and vegetable, and adduces new evidence in favour of this theory.

ALTHOUGH to a great extent dependent on chemical investigation, the subject of the origin of petroleum is essentially concerned with geological inquiry and speculation. It is obviously a question of much economic importance and in need of further researches, especially as much in relation to the mode of occurrence must remain insufficiently understood, until more decisive knowledge is attained concerning the genesis, so that such would tend to increase possibilities in oil-finding.

It is by no means attempted in this article to present anything approaching an exhaustive account of the many hypotheses which have from time to time been advanced to elucidate this still obscure subject, but merely to give a brief discussion, from a geological aspect, of various theories and evidence, with personal observations and conclusions.

Up to the present time, it cannot be said that any hypothesis has given universal satisfaction, or been accepted as conclusive. It is, however, probable that no single theory of origin suffices to meet the case.

The theories of origin may, of course, be in the first place broadly grouped as either organic or inorganic. It appears, however, as highly improbable that any commercial supplies of petroleum can have originated in an inorganic manner, although in some cases where small quantities or traces of hydrocarbons occur in association with igneous rocks, or with volcanoes, it may have arisen in this manner. It will not therefore be necessary to dwell at any great length on this mode of origin here.

INORGANIC ORIGIN.—Small amounts of hydrocarbons have been found in meteorites, which circumstance has given rise to the theory that such substances existed in the original material of the earth, or what has been termed the "cosmic" theory of origin, as advanced by Sokolov,[1] who also adduced in support the occurrences of bitumen in igneous rocks and the presence of carbon and hydrogen in the pyrospheres of celestial bodies. It may be mentioned in this connection that it has been found possible to obtain small quantities of hydrocarbons from igneous rocks,[1] for instance, granite, gabbro, gneiss, basalt, etc., in which they are present usually in the gaseous condition.

In respect of inorganic hypotheses, it may perhaps not be necessary to describe the notable theories which were formulated by Mendeleef,[2] or include the theory suggesting an origin from the action of percolating carbonated waters on metallic iron at a high temperature deep down beneath the surface of the earth (the higher specific gravity in the interior of which might be due to the presence of metals), or the hypothesis founded on the circumstance that the action of water, or steam, on metallic carbides, can produce hydrocarbons. In view of the high specific gravity of the earth, it was thought that such carbides might largely exist beneath the surface. However, the existence of improbably large quantities of metallic carbides, within access in the earth, would be required, if only to suffice for originating the amount of petroleum which has been produced, as the amount of metallic carbides demanded is very great in proportion to the petroleum which can be produced from them. Furthermore, the circumstances that large deposits of petroleum are only found in the stratified rocks, that the deposits found in the strata of younger age predominate, and that very frequently barren porous beds are intercalated with the petroliferous ones, or the strata subjacent to an oil-series do not contain petroleum, all tend to constitute evidence contrary to the supposition of the deep seated origin.

Attempts have been made to show a connection between the distribution of oilfields and regions of abnormal magnetic variations, and that the latter may be due to the presence beneath the surface of magnetic metallic carbides, this view being considered to constitute evidence compatible with the theory of origin from metallic carbides.[3] It appears certain, however, that no such marked correspondence,

(1) *Bull. Soc. Imp. Nat. Imp. Mosc.*, ser. 2, vol. 3, pp. 720–39 (1890).

(1) Tilden, W. A., *Proc. Royal Soc.*, vol. ix, pp. 453–57 (1897).
(2) *Jurn. Russk. Fiz.-Khim. Obshch.*, vol. ix, Otd. i, pp. 36–7 (1877) and vol. x, Otd. i, pp. [illegible] (1878). *Bull. Soc. Chim. de Paris*, vol. i, p. 5[illegible]
(3) Becker, G. F., *Bull.* 401, *U.S. Geol. Survey*

between the positions of oilfields and irregularities in the lines of magnetic variation, is generally to be found.[1]

Another inorganic hypothesis is that which is sometimes called the "mining"[2] theory of origin, and has been suggested in view of the frequent association of sulphur and gypsum with petroleum. It endeavours to explain the origin of petroleum by the action of the gases sulphur dioxide and sulphuretted hydrogen on limestone, which, when water is present, could produce petroleum, gypsum, and sulphur;[3] while, incidentally, the origin of the gypseous deposits, which are in so many localities associated with petroleum (either in massive beds, as in the Red Sea and Persian areas, or in veins, and in the form of the crystalline selenite, as in many other localities, for instance, Russia, Trinidad, etc.), could be in like manner explained, as also the frequent presence of sulphur in the oils.

It is probable, however, that the gypsum found in association with petroleum has generally been formed in a stratiform manner or is contemporaneous with the beds in which it is found, especially when it occurs in intercalated beds of great thickness (for instance, in the Samara division of Russia, and in the Red Sea and Persian areas), while sometimes organic remains are enclosed by it. Moreover, gypsum, or the crystalline form, selenite, is of very frequent occurrence, unaccompanied by hydrocarbons, as in many clays, for instance, the Ampthill clays and others in Britain; also in massive deposits, as in the older non-petroliferous series in Trinidad.

Before leaving the subject of inorganic hypotheses, it may be recalled that some time ago O. Fisher, quite independently of any surmises as to the origin of petroleum, while discussing the condition of the infracrustal regions of the earth's interior, with a view to meeting certain astronomical questions concerning the rigidity of the earth and the absence of appreciable tidal perturbations in the earth's crust, advanced the theory that there was a liquid sub-stratum saturated with gases which were dissolved in the molten magma, it being supposed that the compressibility of the gases would account for the absence of measurable tides in these regions of the planet, and thus remove the principal argument for rigidity;[4] it was at the same time considered probable that the gases might be hydrogen or compounds of hydrogen.

(1) Tarr, W. A., *Econ. Geol.*, vol. vii, No. 7, pp. 647–661 (1912).
(2) Wade, A., *Geologists' Assoc.*, vol. xxiv, pt. i. (1913).
(3) Ross, O. C. D., *Rep. Brit. Assoc*, Section C. 1891, p. 639. Hume, W. F., *Cairo Scient. Journ.* vol. iv, No. 48, p. 14 (Sept. 1910).
(4) Fisher, O., "Physics of the Earth's Crust," 1889.

ORGANIC ORIGIN.—Turning now to the organic hypotheses of origin, there are, of course, both animal and vegetable possible sources, and such might be sub-divided into those of marine or aquatic animal organisms and micro-organisms (both animal and vegetable), of marine vegetation, and that ascribing a derivation from terrestrial vegetation.

It has been chemically demonstrated, notably by Engler and Höfer,[1] that, under certain conditions of temperature, pressure, and confinement, it is possible to produce liquid hydrocarbons from animal remains. The former obtained petroleum-like products by distillation from menhaden oil, fish, and mussels. Moreover, bitumen has been found associated with fossil mollusca and corals, and traces of petroleum have been found in fossil fish. Petroleum has also been found in association with coal (although many such cases may be due to impregnation), while products resembling natural hydrocarbons have been obtained by the action of superheated steam upon wood.[2] Furthermore, it is possible to obtain petroleum in small quantities from peat, and from certain kinds of sea-weeds.

It is thus apparent that there are many organic raw materials which can originate petroleum under suitable conditions, among which is that of their being quickly covered up by deposits.

Striking support is given to the organic hypotheses of origin—both animal and vegetable—by the optical characters of petroleum, as evinced by the behaviour in polarized light, as originally shown by Rakuzan.[3] Petroleum, as occurring in nature, is most usually optically active, that is, it rotates the plane of polarized light, while similar hydrocarbons of chemical production are not optically active, that is, isotropic. Exception, however, has been found in some oils, usually among the light, pale descriptions,[4] for instance, in some from Surakhani, Caucasus, and Velleia and Montechino, Italy, and also one variety from Japan.[5] This characteristic was supposed to be due to

(1) "Das Erdöl," 1919. *Min. Journ.*, vol. cvi, No. 4118 (1914). *Ber. Deutsch. Chem. Ges.*, xxi, pp. 1816–27 (1888); xxii, 592–97 (1889).
(2) Orton, E., *Bull. Geol. Soc. Amer.*, vol. ix, pp. 80–100 (1898).
(3) *Jurn. Russk. Phiz. Khim.*, xxxvi, p. 554 (1904), xxxvii, pp. 79–85 (1905), and xxxviii, p. 1129 (1906).
(4) Incidentally, this circumstance would seem to support the view that, in the cases (comparatively rare) of the occurrence in nature of such very light oils, such may be due to natural distillation, since the greater part of the cholesterol—when distilled—is found to be associated with the higher boiling fractions, while also lower fractionations from the same substance have been found to be optically inactive.
(5) Rakuzan, M. A., Ibid., xxxix. p. 634 (1907).

the presence in natural petroleum of small quantities of the alcohol cholesterol ($C_{24}H_{46}O$), one of the zoosterols, and the phytosterols, the former of which occurs in the animal-fats and oils, while the latter (sitosterol-$C_{27}H_{46}O$, etc.) is found in vegetable-oils.[1] As cholesterol is supposed to be the most usual ingredient, and to be representative of the larger amount of organic sources, it has thereby been considered that animal products must have furnished the principal origin. Later investigations, however, have tended to cast some doubt on the general presence of these substances in all petroleums having been clearly established.[2]

While it appears probable that in many cases and conditions marine animals or the smaller marine organisms may have given rise to the occurrence of petroleum, and such would seem the most feasible hypothesis, it is, however, by no means advisable to accept a general marine-animal origin for all petroleum deposits. It is also quite possible that vegetable remains (terrestrial as well as marine) may, in certain instances, have been an important contributing factor in providing petroleum, either sometimes in conjunction with the animal agencies, or possibly independently.

Marine-Animal Origin.—In support of a marine organic agency of origin, cases may be advanced that petroliferous beds occur in many regions in strata deposited under marine conditions, where terrestrial vegetation could not have been readily available, and sometimes, but rarely, even under deeper sea conditions. Moreover, proofs of abundant marine life are frequently existent in series of deposits in which petroleum occurs. In many regions, for instance in the petroliferous areas in Russia, abundant remains of marine organisms, such as molluscs, echinoids, corals, etc., as well as those of the smaller marine organisms, and sometimes of fish, occur in the beds associated with the petroleum, while in the petroliferous strata of California, and elsewhere, abundant remains of the smaller marine organisms (animal and vegetable), such as foraminifera and diatoms, as well as algæ, exist, and it is difficult not to connect the former abundance of those organisms with the occurrence of petroleum, more especially as traces of petroleum have been obtained from similar organisms living at the present day, as in diatoms, etc., and in marine muds of organic detritus, as in the gulfs of Mexico, Suez, etc.

In connection with a marine-animal origin, mention may be made of an observation made by the writer of a curious but suggestive occurrence in the deltaic regions of the Mahakan river in Koetei, Dutch East Borneo. Attention was called by some natives to the occurrence of small quantities of petroleum in a well in a locality near a creek of the delta and situated on extensive alluvial flats, the presence of the oil rendering the water unfit for drinking. The occurrence of petroleum in such a situation appeared strange, as the nearest Tertiary beds were at a considerable distance, and even there the petroliferous horizons had sunk to considerable depth beneath later Tertiary beds which were not petroliferous; moreover, the alluvial deposits in the vicinity of the well, which was not far from a deltaic estuary, should be of considerable thickness, and include argillaceous material. It did not, therefore, seem probable that the oil could have infiltrated from below to that position; furthermore, there were several other wells which had been dug by the natives for water on this alluvial flat, and none of the others displayed the traces of petroleum. The oil occurring in this well appeared of a clear and fresh nature, and unlike that of the usual seepages found in the petroliferous Tertiary formation; the drops could be seen to be rising from the bottom. Accordingly, in order to investigate this occurrence, the writer had the well baled of water and dug deeper. After a while a collection of remains of many mollusca, corals, and echinoids was disclosed, which appeared to occur in a sort of pocket and were intermingled with fine sand; it was evidently an aggregation or shoal which had formerly been washed together. All the organisms were saturated with this peculiar light-coloured but strongly smelling petroleum,[1] the associated sand being comparatively less saturated. On opening some of the bivalves they were found to contain fine sediments strongly saturated with this oil. The absence of any traces of petroleum in the surrounding sands and alluvium, but found only in association with these marine remains occurring in a pocket, would suggest a connection between the two circumstances. The organisms were found to be of Post-Pliocene age.[2]

Another somewhat remarkable circumstance was also noticed by the writer in north west Borneo, on the Klias island. A test-pit was dug to a depth of about forty feet in soft dark-grey shale. No traces of petroleum were

(1) Lewkowitsch, J., "Chem. Technology of Oils, Fats and Waxes," 1913, vol. i.
(2) Redwood, B., "A Treatise on Petroleum," 1913, vol. i, p. 281.

(1) Some of this oil was collected and afterwards examined, it being found to be similar to petroleum.
(2) The specimens were examined by Mr. R. Bullen-Newton, F.G.S., of the British Museum.

found in the hole until a depth of about thirty-five feet had been reached, when a strong seepage appeared in a corner of the hole, and hard rock was found in the same place. Further excavation revealed the rock to be a large block of hard coral-limestone, not *in situ*, which was present on the side of the hole. On breaking the limestone with a pick an escape of gas took place, and the exudation became stronger, it being found that it came from the limestone block which was saturated with petroleum. Over a gallon of a very light and clear oil, which contained a large fraction of spirit-constituents and was highly inflammable, was gradually obtained from the exudation during the course of several days. This occurrence is mentioned as the circumstances are peculiar, inasmuch as the block of limestone was not connected with other limestone or associated with any petroliferous bed from which it could have derived the oil by infiltration ; and if it had formerly been broken off a limestone which was originally petroliferous, it does not appear likely that it could have retained so much petroleum and gas before it became sealed by the surrounding clayey shales which must have been of comparatively slow deposition. The only other alternative to an indigenous condition would be that the petroleum was derived from finely divided organic matter in the shales, having concentrated, by adsorption or capillarity, in the limestone, although it would be difficult thus to explain the presence of gas under pressure.

Similarly, petroleum has been found associated with coral-reefs, for instance, in the Red Sea,[1] in positions where it could not very well have had an extraneous origin.

A difficulty in the hypothesis of origin from marine animals, principally, however, affecting the case of the larger organisms having hard parts, is found in the usual absence in the actual petroliferous seams of their tests, shells, or other remains, although this would only be in case of the assumption that the petroleum is indigenous to the beds in which it is found. Moreover, in petroliferous series, where some beds contain abundant remains of marine organisms, as in Russia, these do not usually themselves exhibit traces of liquid hydrocarbons or bitumen, but the petroliferous seams are generally found separated from them, although often present in the immediate neighbourhood or in superjacent positions.

It is, however, probable that, in the case of most deposits, the petroleum is adventitious, not having often originated at the horizons at which it is found, but migrated to other beds, where greater porosity favours its accumulation and storage.

In order to meet such conditions as mentioned above, it could be advocated that the petroleum had been entirely expelled, by means of volatilization or distillation, from the horizons containing the organic materials which produced it, and, a suitable medium or sufficient outlet for gaseous emanation having been available, had condensed in and permeated superjacent porous beds protected by an impervious cover. Sufficient heat, by which the hydrocarbons might have been volatilized, could have been generated by the folding movements and pressure in the strata and consequent friction, which may not have produced so much heat in loose porous beds as in the more compact and finer grained limestones, marls, etc. ; furthermore, an increase in pressure in the upper porous beds, as the rising gases became imprisoned beneath their impervious cover, may have also aided condensation in them. Or this process may likewise have been performed by slow distillation[1] at a low temperature.

Such migration in the gaseous condition, however, could not be readily considered feasible in the case of heavy oils with solid residues, as in the case of the great majority of deposits, although the very light oils, which are found at various places, for instance, at Surakhani, in the Apscheron peninsula, and at Tabaquite, Trinidad, etc., have almost certainly been thus produced. Moreover, some residual traces of bitumen would in such a case be expected to remain, associated with the organic remains in the original beds.

It is, however, possible for migration and expulsion to be also effected in the liquid state (the solid residues being included or dissolved in the oil) by means of either capillary attraction and adsorption, or by being squeezed out under pressure into adjacent porous beds ; also, in the case of the original rock or deposit being at all porous, by hydrostatic action and hydraulic pressure.

It is remarkable how quite heavy petroleums can thus penetrate seemingly impervious argillaceous rocks, while it may also be caused to pass through cracks, or small fissures, such as small slip-planes or joint-planes, etc., sometimes in this manner traversing considerable thicknesses of beds.

A remarkable example of this migration

(1) Fraas, O., *Bull. Soc. Scient. Nat. Neuchâtel*, T.viii, [illegible]

(1) As suggested by Newberry, J. S., "Geology of Ohio," i, p. 158 (1873).

through considerable thicknesses of argillaceous material is found in Trinidad, where inspissated petroleum has at places penetrated the Miocene clays through a great thickness, having risen up cracks, such as in minor slip-planes, joint-planes or other minute fissures, along which asphaltic residues have often been deposited, while also it appears to have permeated, or become diffused through, portions of the rock by means of adsorption.

Another method and different manner of migration—by sedimentary transportation—will be considered later.

The origin cannot always lie in the seat of occurrence, more especially as the petroleum is rarely confined only to a single bed or horizon of a series, but usually it is found that most, and often all, of the porous beds in the series have become impregnated, that is, in the area where they occupy positions of suitable structural conditions.

Moreover, petroleum deposits generally occur, with some notable exceptions, in ferruginous sands, grits, or even coarser-grained rocks and conglomerates, the conditions during the deposition of which would not have favoured the organic life which has furnished the source.

In some instances, porous limestones, as for instance, the detrital limestones of the Persian Gulf and Red Sea regions, the fissured limestones of Tamasopa and San Felipe in Mexico, and those of the Corniferous and Niagara, and the dolomitic Trenton in North America, act as the oil-bearing strata; and in the latter cases have been considered to constitute the seat of origin,[1] although such cases might of course be due to impregnation.

It may be noticed, however, that no less an authority than H. von Hofer[2] expressed the opinion that petroleum is indigenous to the beds in which it is found.

The lack or paucity of phosphates in petroleums or in the containing deposits has been considered as an objection to animal-origin,[3] although, as regards the absence in the beds, calcium phosphate is of course generally present to a certain extent in sedimentary rocks (otherwise the luxuriant vegetation conspicuous in so many regions where petroleum is found could not thrive). Moreover, the petroleum accumulations represent concentrations from extensive areas, while they are in most cases adventitious.

(1) Sterry Hunt, "Geology of New York," iii, p. 33.
Orton, E., "Rpt. on the Occur. of Pet. and Asphalt Rock in W. Kentucky," 1891, p. 43.
(2) *Min. Journ.*, vol. cvi, No. 4119 (1914).
(3) Cunningham-Craig, E. H., "Oil Finding" (1914), p. 9.

Furthermore, calcium phosphate is soluble in saline water, and also to a certain extent in water containing carbon dioxide (whereby the plants, dependent on phosphates, are able to absorb it). The frequent association of salt or saline deposits with petroleum, suggestive of an origin under saline conditions or in desiccated basins, will be further considered later; while carbon dioxide may also have been present, and was probably a product in one of the stages in the formation of petroleum. It is therefore possible that much of the calcium phosphate may have been carried away in solution.

If extensive phosphatic deposits or nodules are to be expected wherever animal remains have plentifully existed in deposits, the same might be expected in the case of all limestone-strata.

In regard to the absence of phosphates in the petroleum itself, in the peculiar process of decomposition, or reduction (perhaps influenced by a special kind of bacterial action to which further reference will be made, whereby the hydrocarbons were produced), gaseous or volatile hydrides might have been formed. The presence of phosphorus, however, has been found in some oils.

Likewise, lack of nitrogenous substances in petroleum has been regarded as an incongruity to an animal origin, although the vegetation-hypotheses would also be thereby affected. Nitrogen, however, is a common constituent of natural gas,[1] while nitrogenous compounds or bases are generally found in solid bitumens,[2] and are usually present in crude oils, in small but very variable amount, in some cases reported to vary according to facilities for exposure or to increase with depth.[3]

It seems, however, possible—in the manner suggested by Engler and others—that the nitrogenous tissues may have been first affected and most of the nitrogenous substances removed in the particular process of decomposition, in which bacterial action probably played a part. Such a selective putrifaction, whereby the nitrogenous portions first decomposed the fatty materials remaining, is under certain conditions found to be proceeding in nature; that this may actually take place would seem to be demonstrated by the last-mentioned authority having found the decomposing remains in an

(1) In some cases, gases containing as much as 80% in Kansas, and even nearly 98% in Oregon, have been found, but such are of course abnormal. Cf. Henderson, J. A. L., *Journ. Inst Pet. Tech.*, vol. 2, No. 7, pp. 197–8 (1916).
(2) Richardson, C., *Journ. Soc. Chem. Indust.*, vol. xvii, p. 13 (1898).
(3) Redwood, B., "A Treatise on Petroleum" (1913), vol. i, pp. 237–8; Mabery, C. F., and Dunn, O. C., *Amer. Chem. Journ.* vol. xviii, p. 215 (1896).

organic mud to contain a larger amount of fats than that of the living organisms.

It seems probable that such bacterial action, of the anærobic type, and decay in deficiency of air, possibly also associated with saline conditions, may have had an important role in the formation of petroleum, and it is to be expected that such conditions would produce different results from those attending ordinary atmospheric decay.

Micro-Organic Hypothesis.—With reference now to the smaller marine organisms (also those other than marine to a limited extent) as a probable source of origin, or what might be called the micro-organic hypothesis, such forms of animal and plant life, as the protozoa, diatoms, and small algæ, which exist in such great abundance and are short-lived but multiply rapidly, would certainly appear to present very suitable conditions for the purpose. Moreover, their remains are frequently associated with oil-bearing deposits, being generally present among Tertiary petroliferous series in various parts of the world, especially in the tropical regions, where they, notably those of the foraminifera, are almost invariably found. Mention in this respect may be made of the orbitoidal limestones and marls—composed almost entirely of these foraminifera, with also some other forms, and often together with nullipores—which are frequently found associated with the petroliferous Tertiaries, as in Borneo and Trinidad; doubtless, further investigations will reveal such beds occurring in similar conditions in other regions. Among other examples, allusion may be made to the frequent association of the foraminiferal beds, in the middle Tertiary series of south Russia, with the oil-bearing deposits, for instance at Maikop, where such beds underlie the main oil-sands; and also to the case of the foraminiferal limestone (Asmari) of the Persian Gulf area.

Further, there are the notable and suggestive conditions found in southern California, for example, in the Coalinga district,[1] where the petroleum deposits in the lower Miocene are considered to be derived from the underlying Eocene shales, or Tejon series, composed of an abundance of the tests of diatoms and foraminifera. These are regarded by Arnold as sufficient to produce more than all the petroleum contained in the oil-bearing series. It is a remarkable circumstance that the Miocene beds are only petroliferous where overlying these diatomaceous shales, not being so where they rest unconformably on the Cretaceous, while their productivity is said to be related to the proximity of the Tejon shales.

(1) Arnold, R., Bull. 357, U.S. Geol. Surv., 1908.

Diatoms, as aquatic plants building up their organic material under the influence of sunlight from carbon dioxide and water, without forming starch or sugar as a product of assimilation, would appear as well adapted for forming products such as the hydrocarbons, or substances giving rise to them; moreover, included in the plasma of some species, minute globules of oil have been detected;[1] while G. Kramer and A. Spilker[2] obtained from a diatomaceous ooze (seeschilck) underlying a peat-bog in the sub-division of Uckermark, Northern Germany, a substance resembling paraffin oil, and, by other treatment, a wax possessing great similarities to ozokerite. In a process of origin from diatoms propounded by these investigators, ozokerite is supposed to be first formed, and the liquid hydrocarbons therefrom. In this connection it may be mentioned, however, that the study of the geological occurrence of natural ozokerite tends to show a reverse condition, and that this substance is evidently a residual product of the oil. Although minute, the prolific abundance in which the diatoms exist in all latitudes of the sea, as well as in fresh water and marshes, is such as to provide appreciable materials or sufficient sources.

A derivation has been advocated by Potonié[3] from the muddy slimes, or "sapropel," supposed to be formed from gelatinous algæ, occurring in association with stagnant waters, as in the case of the boghead or cannel coals, although it appears probable that the spores of terrestrial plants, such as lycopods, may have played the principal part in the latter.

The same investigator found in the mud of the Gulf of Stettin what he considered to be a quantity of the pollen of plants, together with other organic remains, such as algæ and diatoms as well as animal-fragments, and on distillation of the material obtained an oil resembling petroleum.[4]

Likewise, marine muds containing minute organic matter are, in various parts of the world, found to yield traces of petroleum. Siekenberger[5] considered that petroleum was actually forming a scum on the water from organic remains in certain small saline bays in

(1) Pfitzer, in J. Hanstein's Botanishe Abhandlung, 1871 p. 33.
(2) *Ber. Deutsh. Chem. Gesell.*, vol. 32, p 2940 (1899).
(3) *Natur Wochensch.*, vol. 20, p. 599 (1905).
(4) Potonié, H., "Zur. Frage nach den Ur-materialiens der Petrolea," *Jahrb. K. Preuss. Geol Landesanst.*, xxv, pp. 342-68 (1904).
(5) *Chem. Zeitung*, vol. 15, p. 1582 (1891).

the Red Sea, while such organic muds, from which a quantity of petroleum-like oil was extracted, found among coral-reefs in the Gulf of Suez, have been described by Wade.[1]

In Roumania, where there is an intimate connection between the oil-bearing Miocene and Pliocene beds with the Salifère, which is supposed to be the seat of origin, Professor Mrazec[2] has considered that an abundance of micro-organisms capable of living in very saline water has given rise to petroleum.

The association of salt or saline conditions with the occurrence of petroleum appears as almost universal, the former substance either occurring in the solid state, or in the form of natural saline springs, or the salt-waters or brine occurring in the wells.

The saltness of waters found at depth may, however, be merely the not unusual condition of water existing in deep-lying strata. Thus some have endeavoured to explain the occurrence to this latter circumstance and to the absence of conditions conducing to percolating waters and lixiviation, without attaching any great significance to the relationship.

In most petroliferous regions, however, the saline conditions are too pronounced to admit of being considered normal, their presence being manifest in the strong brines, or, in the case of a markedly saline condition of the strata, often giving rise to efflorescence, for instance, in the Caspian or in some of the Caucasian regions, while considerable deposits or beds occur in several oil-regions, too numerous or well known to need recital here; also, the waters accompanying mud-volcanoes are generally saline; while in this respect mention may be made—as a somewhat peculiar manifestation in oil regions—of the occurrence in the island of Tcheleken of highly saline thermal springs, often rising to the surface under considerable pressure.

It seems, therefore, apparent that the conditions of formation were generally under saline conditions, as in desiccated basins, land-locked inlets, shallow bays, or inland seas.

In an inverse manner, natural gas and traces of petroleum are in many cases found in association with important salt-deposits, where the former is sometimes utilized for the illumination of the mines.

It has been considered that the presence of the salt may have contributed to the process of formation, by arresting putrefaction, preserving, or modifying the decay of the organic matter, while some have considered that it served as an active and necessary reagent in the chemical process by which petroleum resulted, or have attributed to it, as also to other associated salts besides common salt, such as the chlorides of magnesium or aluminium and bromides,[1] some obscure chemical action in the transformation of the original materials. It is possible, however, that the salinity may have had an effect in determining the type of bacteria employed, and thus the particular process of decomposition adapted to the formation of petroleum.

Other suggestions have been made respecting a sudden advent of an increased salinity in waters having effected a general mortality of animal life, thus providing a larger amount of organic materials as a source of formation. One explanation of the relationship, however, may be found in the higher specific gravity of the water, on account of the salinity, having conduced to concentration and facilitated the separation of the oil from the water. Thus accumulations would be more likely to occur where the conditions are saline.

But the most important significance of this association lies in the indication of the conditions attending deposition, that is, those of desiccation.

The frequent association of gypsum (or selenite)—either in form of veins or in stratified deposits—has already been referred to and may also be explained by desiccated conditions, rather than by some obscure chemical action.

Furthermore, the occurrence of dolomitization sometimes accompanies that of petroleum, and is also indicative of similar conditions, although a cause for the connection is also to be found in the rendering porous of the limestones by this process, and the consequent provision of a suitable rock for containing oil.

It must be admitted, however, that the conditions found in all oil regions are not invariably those of desiccation. In the oilfields of Borneo, for example, such saline conditions are not conspicuous, although salt-waters are found at depth; but the latter circumstance, as above noted, may not of necessity be regarded as an abnormal occurrence. Also gypseous deposits are not there in evidence.

Terrestrial Vegetation Hypothesis.—Turning now to the terrestrial vegetation hypothesis, adherents to this mode of origin point to the association in some places, such as in Borneo, Burma, Trinidad, etc., of coal and lignite with petroleum, and to the alleged circumstance that sometimes a coal or lignite seam may be

(1) *Mining Magazine*, Aug., 1914.
(2) "L'industrie du Pétrole en Roumanie," Bucharest (1910).

(1) Ochsenius, C., *Chem. Zeitung*, vol. 15, p. 935 (1891); and *Zeitscht. Deutsch. Geol. Gesell.*, vol. 48, p. 239 (1896).

found to merge into one which is petroliferous.[1] Also, attention has been drawn by Cunningham-Craig[2] and by Wall and Sawkins[3] to the occurrence in Trinidad of curious red and apparently burnt seams, termed porcellanites, which the former regarded as being in a condition of transition between lignite and petroleum-bearing beds. (These porcellanites, however, were supposed by Richardson[4] to be due to the disintegration of the pitch, and to consist of the mineral residue.) It does not, however, appear as conclusive that the condition of a coal-seam passing into an oil-bearing rock, in the identical bed, actually obtains, although they are not infrequently associated as separate beds in the same series.

Perhaps the most marked examples of the association of a coal-formation with the occurrence of petroleum are those found in Borneo, where the oil-bearing sands are intercalated in the series with numerous seams of brown coal, often of great thickness, but occurring at different horizons in independent beds, in which any passage from the one into the other is not observable.

In many fields, however, in fact in the majority, no coal or lignite is found associated with the petroleum, and often the conditions under which the strata were laid down do not favour the probable proximity of large quantities of terrestrial vegetation. Moreover, difficulty in the terrestrial vegetation hypothesis is found in the general absence in the petroliferous beds, and frequently in the adjacent strata, of the remains of terrestrial vegetation, the hard parts of which would not be likely to entirely disappear, not even any traces of the original fibrous and cellulose structures being usually discernable. Moreover, cellulose on distillation would leave a carbonaceous residuum. Migration may of course have taken place—in the manner considered above—to overlying porous beds from the source of origin, in which case, however, the presence at the latter of beds containing indications of vegetable remains, and of some residual traces of bitumen in connection, might be expected in the locality; while the close association of true bitumen with the remains of terrestrial vegetation, or coal, is not of general occurrence.

A somewhat different aspect, however, has been placed on the terrestrial vegetation hypothesis of origin by the possibilities of the transportation of the petroleum to the places in which the beds containing it were deposited,

(1) Cunningham-Craig, E. H., "Oil Finding," 1914, pp. 16-17.
(2) Ibid, pp. 17-19.
(3) "The Geology of Trinidad," 1860.
(4) *Journ. Soc. Chem. Indust.*, vol. xvii, p. 19 (1898).

and by researches into the behaviour of petroleum in water containing clayey sediment, and its sedimentary deposition.

As in the case of coal, in which the transportation theory of origin has served to explain some cases in which there is an absence of evidence, such as trees rooted in the under-clays, etc., of the coal having been formed *in situ*, so, in the case of petroleum, a transportation theory of origin might explain how the hydrocarbons may have been derived from terrestrial vegetation without the series of deposits in which they are found containing evidence of the remains of terrestrial vegetation.

It has frequently been noticed that oil floating down streams eventually disappears; where does it go to? It is not likely to disappear so soon by reason of evaporation.

In researches carried out on the behaviour of oil in the waters of streams, etc., by Murray Scott[1] in Burma, it was found that the oil disappeared in water containing clay-sediment. It was found that this was due to the clayey sediment having an affinity for the oil, minute particles adhering to the globules of oil, until the latter were weighed down and collected at the bottom of the water.

In this way petroleum might be deposited under water over extensive areas, such as on littoral or estuarine tracts. A change in the conditions might bring about a deposition of sand in place of the clay, and, as the weight of the overlying sand increases, the petroleum mingled with the clay would become squeezed out and absorbed in, or migrate to and permeate, the porous sand. A recurrence to the former conditions and a further change in the nature of the sediment might bring back the clay, which would then form an overlying impervious deposit sealing the petroliferous sand-bed below. Thus, a series of petroliferous beds might be formed, and if at times the source of the petroleum became temporarily stopped, some of the interstratified sand-beds would be barren; there would then be present a series of petroliferous sands, with some intercalated barren sand-beds, interstratified with clays and shales, just as is found in nature.

This manner of deposition of petroleum by transportation might serve to explain the occurrence of seams of coal or lignite merging into petroliferous beds, where such conditions have been supposed to occur.

This mode of deposition, however, is not, of course, only applicable to the hypothesis of terrestrial vegetation, but also to that of marine origin, serving as a possible explanation of the

(1) Rec. Geol. Surv. India, vol. xl, 1910.

way in which petroleum, whether of animal or vegetable origin, may have been deposited and permeated the beds in which it is found, before it became further concentrated by geotectonic agencies.

In this connection it may be mentioned that it has been shown by Gottier that liquid hydrocarbons can be formed from marsh-gas in the presence of certain chlorides, such as rock-salt, and calcium chloride; marsh-gas is, of course, a common product of vegetable origin and decomposition, and in regions covered with dense vegetation or jungle-country, particularly when swampy, considerable quantities may be produced. This circumstance, if taken in conjunction with the transportation theory, would appear to present striking possibilities for accounting for the origin of some deposits of petroleum.

With reference to the possibility of oil-deposits being derived from coal, by means of natural distillation, and thus indirectly from terrestrial vegetation, an objection to a carbonaceous origin appears in the nature of the products obtained from the destructive distillation of coal, which contain a predominance of the hydrocarbons of the benzene and aromatic series, with also a considerable amount of phenolic substances, while such cannot be said to be the case with petroleum, although a minor amount of the hydrocarbons belonging to that series and small quantities of the last-mentioned compounds are usually found to be present.

Marine Vegetation Hypothesis.—It now remains to consider marine vegetation as a possible source of origin, although reference has already been made to the smaller algæ, such as nullipores, as well as the diatoms, under the consideration of a derivation from marine, or aquatic, micro-organisms.

As has been mentioned before, it is possible to produce liquid hydrocarbons from certain kinds of sea-weed, and marine vegetation may consequently be regarded as providing possible raw materials for the natural production of petroleum.

Marine vegetation thrives for the most part in comparatively shallow water, or on littoral tracts, more especially between tidal limits, frequently being washed together by the waves into accumulations on the shore, and such may become covered up and buried, as in the case of the "warp" deposits, found on the east coast of England. Doubts have been raised as to whether sufficient quantities would be available, or as to whether the areas upon which it existed would be sufficiently extensive, in order to furnish adequate material for producing any considerable petroleum deposits.

It is, however, under shallow-water conditions, such as on littoral or estuarine tracts, or in basins, that petroliferous strata have most frequently been formed. Furthermore, series of strata containing petroleum often exhibit evidence of former land surfaces, the presence of which must have been preceded and followed by extensive shallow-water conditions and shifting tidal regions; this would be more particularly significant in the case of formations containing successions of coal and lignite-seams—as in Borneo, etc.—which indicate secular oscillations centering about the sea-level, whereby large areas must have been at the same time and on several occasions under very shallow water, and extensive tracts would of necessity have been situated between tidal limits, while the land was either emerging from or being submerged in the water, such a condition being favourable to luxuriant growths of marine vegetation. Thus, even in the case of oil deposits in coal and lignite formations, marine vegetation may not have been an improbable factor in originating some of the petroleum, and it is not inconceivable that, while the coal and lignite beds represent land surfaces, some of the intermediate deposits containing petroliferous beds might represent shallow-water conditions or stretches of tidal flats harbouring an abundant marine flora; moreover, it is also possible that the land surfaces, covered with dense vegetation, might merge into such tidal flats or shallow water, with the accompanying marine vegetation, and consequently on sinking, the conditions would be provided which might render possible the formation of a carbonaceous seam passing into a petroliferous bed, the existence of which in some localities has sometimes been reported.

It is not improbable, moreover, that marine flora may have been more abundant in former times, and that various differing conditions may have sometimes favoured a luxuriant growth. As in the case of carbonaceous formations in regions where there is now a paucity of terrestrial vegetation, which present condition cannot be taken to suggest that there was an insufficiency in the past to provide for the material in the coal-seams, likewise, in the case of marine vegetation, it cannot be evinced that there may not have been a greater abundance in the past. In this respect, it has been suggested by the late Professor Vivian Lewes,[1] who has advocated this hypothesis of origin,

(1) Cantor Lectures, "Oil Fuel," *Journ. Soc. Arts*, vol. lxi, No. 3157 (1913).

that the differing conditions in the composition of the sea and of the atmosphere in former times might have conduced to large growths of marine vegetation. Moreover, as was also pointed out by the same authority, very considerable quantities of marine vegetation exist in some parts of the world at the present day; while, judging from the former kelp industry, the quantity obtainable in the British Isles was by no means inappreciable.

Other objections which have been raised to the marine vegetation hypothesis are the absence of bromine and iodine[1] and the presence of sulphur in natural oils. These matters were also considered by the last-mentioned authority[2], who surmised that the halogens present in the sea would have been in a much less quantity at the time the petroleum deposits were formed, and the amount of bromine and iodine salts would have been very small indeed, and, in any case, the amount taken up by the marine plants would probably have been inconsiderable. In Tertiary times, however, there may not have been so very much difference in this respect from the present; in this connection reference may be made to the iodine springs occurring in California, in association with the petroliferous Tertiaries. Also, iodine has been detected in the brines connected with seepages and mud-volcanoes in the Tertiaries in New Guinea.[3]

In regard to the sulphur present in petroleum, it has been shown that sulphur is contained in certain forms of sea-weeds.[4] However, the sulphur contained in petroleum varies in amount very considerably, some being comparatively free, while it need not be supposed that all petroleums, including those containing high percentages of sulphur, are derived from marine vegetation. Moreover, sulphur can have been introduced from extraneous sources, either contemporaneously or subsequently to the genesis of the petroleum; or, it could be formed by the decomposition of gypsum, or iron pyrites, by organic acids. Traces of several other inorganic substances, however, have been found existing in crude petroleum.

Concerning the subject of a derivation from algæ or aquatic plants, the occurrence of a deposit, in Portuguese East Africa, of a substance (termed n'hangellite, after Lake N'hangella) resembling elastic bitumen or elaterite, and yielding petroleum-like oils on distillation, the matrix of which appears to be derived

(1) Cunningham Craig, E. H., "Oil Finding," 1914, pp. 23-24.
(2) Lewes, V., *Journ. Soc. Arts*, vol. lvi, No 3157 (1913).
(3) Wade, A., "Report on Petroleum in Papua," 1914, p. 30.
(4) Lewes, V., *Journ. Soc. Arts*, vol. lxi, No. 3157 (1913).

from gelatinous organisms, said to consist of the blue-green algæ (Chrococcaceae), and contains also diatoms, is of interest. It has been suggested[1] that this material may represent an intermediate stage in the conversion of aquatic vegetation to petroleum. A similar substance (named coörongite) is found in South Australia.[2]

Allusion may here be made to the possible process of origin, in some local cases of deposits, by means of the distillation by natural heat of oil-shales at depth, where such may be present, the hydrocarbons condensing in superincumbent porous beds; such can actually be observed to be the case where volcanic or dyke-rocks intruded among oil-shales have given rise to local occurrences of petroleum. The organic matter, known as "kerogen," that is present in oil-shale and on distillation yields fluid hydrocarbons, has been considered to be due to large numbers of minute gelatinous unicellular algæ—or possibly the spores of plants such as lycopods—a conclusion which the microscopic examination of the shales tends to confirm; in this case, then, the petroleum derived from oil-shales would come under that of vegetable origin. In like manner the oil-yielding cannel and boghead coals have also been supposed to be either algous or comprising spores in their composition and formation.

CONCLUSIONS.—While it appears advisable to accept organic hypotheses of origin, as affording the most probable sources of derivation—in any case in respect of large deposits of petroleum—the very varied conditions under which petroleum occurs, and whereby it must have been formed in or entered into the rocks which contain it, indicate the futility of confining acceptance to any single mode of origin; indeed, some individual deposits may not have entirely originated in any single manner or from any single group of organic matter. It can be shown that under suitable conditions it is possible to produce hydrocarbons from either of the classes of raw materials that have been mentioned, and, in the light of present knowledge, it is not desirable to discard the others for the sake of advocating any particular derivation. The possible sources of genesis may all have contributed, in a greater or less extent, to the dissemination of bitumen in the sedimentary deposits, before accumulation was effected by migration, pressure, and the advent of geotectonic movements which, with the action of water, brought about concentration;

(1) Dalton, L. V., *Econ. Geol.* vol. iv, No. 7, p 618 (1909).
(2) Ibid.

while the transportation theory and the data as to the behaviour and deposition of petroleum in water containing clay-sediments, may throw much light as to the manner in which the petroleum originally accumulated and got into the beds in which it is found.

Furthermore, even inorganic origins cannot be entirely discredited, as cases exist where small traces may have been derived in this manner; bitumen is not infrequently found contained in igneous rocks, as also graphite which may in some cases be a residual product of bitumen; while it has been demonstrated that petroleum is found diffused—mainly in the gaseous condition—in igneous rocks. But there are probably no large deposits or supplies of any utility which have thus originated, and the optical inactivity of inorganic petroleum and the environment, or conditions of occurrence, of the principal deposits, constitute evidence contrary to the acceptance of such a derivation.

The possibilities of an origin from micro-organisms would perhaps seem to be more generally evident, and to be the more frequently supported by available data in the field, especially in the case of the Tertiary deposits; while, as in the case of the observed occurrences mentioned earlier, conditions are to be found which would certainly appear to indicate that other or larger forms of marine organisms have given rise to the formation of petroleum. The terrestrial vegetation hypothesis, on the other hand, would perhaps have the less in respect of geological and chemical facts to commend it, although rendered more practicable by the possibility of the co-operation of the sedimentary transport of oil. It thus appears that the marine-organic hypothesis is the most generally acceptable, and that marine organic remains have contributed the most important factor in originating petroleum, the fatty tissues having provided the principal source.

From a synthetic point of view, however, since the sources of heat and energy contained in all combustible substances must be derived from the sun, it must be admitted that terrestrial vegetation would appear to afford a medium better adapted for receiving and retaining solar energy than animal life or aquatic organisms (in whose environment the intervention of water would mitigate the transmission of such influence), although the diatoms, and perhaps also other small pelagic organisms living near the surface are not unfavourably situated in this respect, while such compose the food consumed by a large number of other marine organisms.

It must be considered that petroleum deposits can seldom be indigenous to the reservoir-rocks that contain them. The latter, in the great majority of cases, consist of arenaceous deposits—or sometimes of coarser-grained material—and it is not to be expected that the conditions attending the deposition of such deposits would be favourable to the existence of organic life, while oil-sands are generally devoid of indications or remains of organisms. Also, it cannot be considered that petroleum or hydrocarbons of that type would be the sole product of the decomposition of the raw materials, without any other products or remains of organic matter; whereas such would seem to be the case if the accumulations of petroleum were indigenous, which would then represent a complete transformation from the original materials. Moreover, it would appear that argillaceous sedimentation is a favourable condition of formation. In cases where arenaceous deposits contain organic remains, the latter appear to have seldom been converted into petroleum. Hence, a movement of the petroleum from the seat of origin to porous beds, where accumulation and concentration have taken place, may be considered to have been generally the case.

In regard to the conditions and process of formation from organic matter, such would consist, following the primary requirement of the rapid covering up and burial of the materials by deposits, preferably argillaceous,[1] of a selective putrefaction by bacterial action under anærobic conditions (whereby most of the nitrogenous matter would be first eliminated), and further decomposition and modification under increasing pressure, with subsequent distillation, separation, and selective migration. Possibly at some time during the process of modification a certain amount of heat may have been available, which may have been due to pressure, heat gradient, and possibly friction attending the folding movements as well as chemical action and fermentation, and have aided in the transmutation or distillation; but time may have taken the place, in nature, of the high temperature required for results in the laboratory. As regards postulations in respect of the various chemical changes or reactions involved in the process of formation, as have been suggested and formulated in a detailed manner by Engler, such would lie beyond the scope of a geological consideration of the subject.

The circumstance that frequently abundant

(1) In the instance, however, noted in the Mahakan Delta the sediments were partly sandy

organic remains exist in strata unassociated with bitumen has been regarded as inconsistent to the hypothesis of organic origin, but the formation of petroleum from organic matter would only take place under certain required conditions or factors, which may be more frequently absent than present. Moreover, the conditions contributing to the preservation or the destruction of the hard parts of organisms may not be the same as those effecting the conversion into bitumen or the dissipation of the soft parts. Furthermore, the petroleum may become lost by the destruction of the reservoirs, or through exposure and consequent dissipation and escape of the bitumen, the liability for such being according to the amount of denudation and disturbance to which the containing strata have been subjected. Thus accumulations are seldom found in Palæozoic strata, unless they are little disturbed, as in the older formations of North America, and of Central Russia.

Finally, the required conditions or factors for the production of deposits of petroleum, originating from organic matter, may be summarized as follows:

(1) Sufficient sources of organic matter (mainly marine and especially micro-organic) and deposition together with rapidly accumulating (preferably) argillaceous deposits, possibly in presence of saline conditions; or transportation of the hydrocarbons by means of clay-sediments and subsequent deposition.

(2) The existence of a suitable medium whereby the bitumen can reach and accumulate in porous beds—either by means of capillarity and adsorption, or through cracks and fissures in the argillaceous or impervious material.

(3) The presence of such porous beds, suitable to serve as reservoirs, within access from the seat of origin, and sealed by impervious material.

(4) The presence of water (preferably saline) in the strata, or water-logged rocks, and the advent of geotectonic conditions favourable for effecting concentration.

The first-mentioned conditionary factors (1) and (2) are not applicable to those occurrences considered to be indigenous, as in limestones, but probably many of such cases may be due to impregnation.

Lastly, it is desirable to consider that bitumen, or natural hydrocarbons of that description, are not only of restricted or sporadic occurrence, but fairly widely and generally distributed and disseminated throughout the rocks, although only becoming conspicuous or occurring in notable deposits where conditions favouring accumulation and concentration have obtained.

MINING AT HIGH ALTITUDES.

By STANLEY C. BULLOCK.

The author records his experiences of mining and milling in the Andes at an altitude of 16,000 ft. and gives particulars of conditions under which work can best be done.

THESE notes are written in the hope that young engineers may be assisted by the experience of others who have undergone the trials and difficulties which are unavoidable at high altitudes in the Andes and other parts of the world.

The author's experience was obtained during a period of two years while operating a copper property on the borders of Chile and Bolivia, at a height of 16,000 ft. above sea-level.

The ore consisted mainly of carbonate and silicates of copper, but almost every other class of secondary copper ores were to be found in small quantities. A comparatively large quantity of the ore could be hand-picked to an average of about 25% copper; this was despatched in bulk by the railway to the port of Antofagasta. Some optimist, however, had advised the construction of a water-concentration plant to treat the mine-tailing dump, which was supposed to average 10% Cu, and which had been already picked over by contractors using hand jigs and hand buddles. When the mill was eventually started the feed was found to assay about 7% Cu, mostly in the form of carbonates and silicates, and the recovery obtained amounted to 40% of the copper content.

The mill consisted of breaker, rolls, trommels, Harz jigs, Wilfley tables, and Frue vanners, and was supposed to have a capacity of 100 tons per 24 hours, but, actually, owing to the light feed which had to be sent to jigs and tables in order to obtain any separation, about 30 tons per 24 hours only could be dealt with. By means of close classification and careful adjustments the recovery was brought up to 60%, the feed having the same assay,

A Bolivian Hand-Jig.

that is, 7% Cu, while the concentrate averaged 25% Cu. The total concentrate produced per 24 hours from 6 jigs, 3 tables, and 3 vanners amounted to only 3,600 kilogrammes, equal to 150 kilos (or 330 lb.) per hour. The average capacity for each machine was as follows: jig, 16 kilos (35·2 lb.); table, 15 kilos (33 lb.); vanner, 3 kilos (6·6 lb.). From these figures, as well as from the composition of the ore, it will be clearly seen that the treatment of this class of ore by water-concentration was not a commercial operation.

In addition to concentration, power and fuel also presented problems to be solved. The boiler was a Babcock & Wilcox colonial type, capable of developing 125 h.p. with a good average steam coal, at sea-level. The only fuel available, however, was a kind of resinous moss called "yareta," which grew among the rocks, and had a calorific value of about 4,000 B.T.U. In order to burn this fuel effectively, the space between the fire-bars had to be increased from $\frac{1}{4}$ in. to $1\frac{1}{4}$ in. on account of the low atmospheric pressure, which was approximately $7\frac{1}{2}$ lb. per sq. in. at that altitude, with the consequent necessity of a greater area for the admission of air to the combustion chamber. The grate area itself should have been treble that actually available if the full capacity of the boiler was to be obtained without forcing. The actual power required to drive the mill, pumps, aerial ropeway, and lighting was 75 h.p., and this could only be obtained by turning all the exhaust from the Belliss engine into the boiler stack, thus causing an induced draft.

Yareta burns with a very long flame, and, under ordinary circumstances, requires very little draught to ensure proper combustion. In the year in question, 1914, it could be purchased for 1·50 pesos (peso = $8\frac{1}{2}$d.) per 100 lb. (Spanish quintal), equal to 3·30 pesos per metric quintal (100 kilos), or 23s. $4\frac{1}{2}$d. per metric ton. It was brought to the mine on the backs of llamas, each animal carrying from 75 to 100 lb. Although some of the supplies were within a day's march from the camp, these areas were gradually becoming denuded and the greater quantity was brought from a more distant field of one or two days' journey.

Though the mines were situated within the tropical zone, the altitude was such that severe frosts and heavy falls of snow were experienced between May and September. The railway, which branched off from the main Antofagasta & Bolivia railway, was often closed for weeks at a time during these periods on account of the falls of snow which drifted and filled the cuttings.

Some of the mines were from 3 to 4 miles

A Group of Bolivian Workmen and Workwomen.

from the mill, and were connected to the latter by an aerial ropeway. With this ropeway once started, and with all the ore travelling on the down grade, a 5 h.p. motor only was required to drive it. When, however, there had been a heavy frost and the rope had frozen to the idler pulleys, it required nearly 30 h.p. to start. Needless to say, the ropeway never ran with the 5 h.p. motor, and a 20 h.p. motor had to be installed before any milling operations could be commenced.

No provision had been made for heating the mill, with the natural result that operations during the winter months were almost at a standstill, owing to there being insufficient boiler capacity to supply steam for heating purposes.

A Herd of Llamas.

The workmen were mostly Bolivians, and, as a rule were hardworking and tractable people, very simple and childlike in their behaviour, except on feast days, when nearly all the men and women became the worse for their festivities and indulgence in alcohol. As a manager in a small camp of this description generally becomes the people's "patrone," and is doctor, adviser, and judge, he can often ensure that these feasts do not last too long by the judicious prescribing of medicine. The excuse for not turning up to work is usually sickness on these occasions, for which a strong dose of Epsom salts is an excellent corrective, and the remembrance acts as a slight preventive on future occasions.

The rate of wages in 1913–1914 was from 6 to 12 pesos (a peso = 8½d.) per day, the former for unskilled labour and the latter for skilled craftsmen. The average would probably be about 10 pesos (7s.) before the war; but it must be remembered that this was considerably higher than the rate in other parts of Chile, owing to the high cost of the necessaries of life, which had nearly all to be brought from the Port of Antofagasta, a distance of about 400 miles by rail.

Practically every mine has its own general store, and a system is adopted by which the workmen can obtain goods on the presentation of his "ficha" book initialled by his superintendent for an amount within his credit. Payday usually takes place about once a month, though sometimes a longer period elapses, but as quite a large proportion of the workmen spend everything they earn the long period between paydays affects them very little.

In conclusion, a warning is given to anyone visiting or intending to live at these altitudes against mountain sickness or "poona," to which every one is subject. It is absolutely essential that lungs and heart should be perfectly sound, and when first ascending great care should be taken to partake only of the most easily digested food and entirely avoid alcohol. The food at most wayside hotels is badly cooked and indigestible, and the steak and potatoes of which the writer partook before starting on the last 4,000 ft. was mainly responsible for his collapse at the end of the journey.

A throbbing headache is usually experienced for about a week after the first arrival. For this there are various remedies, a tincture called "fleur d'orange" being certainly beneficial. In subsequent journeys on business up and down to the coast no inconvenience was experienced whatever, mainly due to careful dieting. In other respects the climate is perfectly healthy. No germs or flies seem able to live, and there is no disease. But it is undoubtedly unwise for anyone not brought up in these altitudes to remain in them for more than 2 or 3 years. As regards mine and milling equipment, engines (especially gas or oil), compressors, boilers, pumps, &c., should all be chosen with regard to the rarity of the atmosphere, and the effect thereof on their respective capacities.

THE CHINA CLAY INDUSTRY OF
THE WEST OF ENGLAND.

By HENRY F. COLLINS, A.R.S.M., Assoc.M.Inst.C.E., M.Inst.M.M.

(Continued from the December issue, page 337).

USES OF CHINA CLAY.—The two chief uses of china clay are for papermaking and pottery. Strange as it may perhaps seem to the uninitiated, the proportion of the total pre-war output used for the latter purpose was a trifle less than one-third of the total, the largest section of the output being employed in papermaking. The consumption of china clay for other subordinate uses, is, however, rapidly increasing. Among such uses may be mentioned:

(1). As a stiffener, mixed with size, for cloth and other textile fabrics.

(2) For the manufacture of sulphate of alumina, and of alum; the more aluminous clays are, naturally, preferred for this purpose.

(3). In the manufacture of ultramarine. Before the war it is said that from 12,000 to 15,000 tons were used for this purpose in Germany alone.

(4). As an absorbent and stiffener in the manufacture of linoleum, papier-maché, india-rubber goods, white celluloid goods, and modelling materials.

(5). In the manufacture of special wall plasters, whitewash, and distempers (particularly in the United States); and also for toilet and tooth powders, polishing and plate powders, cleaning soaps, coloured chalks and crayons, etc.

(6). For the adulteration of whiting, and of various zinc and lead mixed white pigments, and plaster-of-paris; also as a filler to give body and weight to asbestos and other patent packings; also to chemical manures, and as an adulterant of certain articles of food which are sold in powdered form.

China clay is always employed in papermaking as a "filler"; that is to say, mixed with size, as a material for filling the pores or voids between the shreds of fibre or vegetable pulp that form the grain or skeleton of the paper, in order to give it body, and a solid and smooth surface. For best quality white paper, only the whitest clays of "best" grade are employed. Even for cream or other tinted writing and printing paper, clays of at least good medium grade are preferred, the required colour being added to suit. This is because the tint can thus be kept more under control, and because the commoner clays are not only yellowish, but the particles of which they are composed, being often coarser, are not so readily kept in suspension. It is only for newspapers, etc., that a clay of low medium or common quality can be used.

Sometimes clays of two different qualities are employed in papermaking, a somewhat inferior kind (if fine enough in grain) as a "filler," that is, for mixing in as an integral part of the paper pulp itself, and a superior kind as a "coating clay." For the "coating" process, the half finished sheet of paper is passed through a bath of size and water containing in suspension a proportion of high-class clay, in order to give a smooth and glossy white surface coating. This process is adopted in making paper for "process" blocks and other illustrations, as well as for other purposes, more especially in the United States, where paper with a smooth and glossy surface is more highly esteemed than in England.

The colour of medium-grade clays for papermaking is often improved by admixture of a certain proportion of aniline blue, which is mixed into water in a barrel, and allowed to drip by means of a syphon into the stream of clay water on its passage to the settling pits, in any desired proportion. China clay has such a great capacity for absorbing pigment of any kind that, however soluble the dye, it is all taken up by the clay, leaving the overflow water as free from colour as if no blue had been employed. The very highest class of china clay has a smooth and almost dead-white colour without any such extraneous assistance. The "seconds" quality product from slightly stained portions of a clay pit ordinarily yielding a fine-grained high-class clay is often brought up to standard colonr by this means, which is also in favour for bringing up "low medium" clays to an acceptable tint.

The total output of china clay from Cornwall and Devon during the years 1912 to 1914 was about 850,000 tons. Out of this total not more than 100,000 to 150,000 tons were consumed for all other purposes other than potting and bleaching, leaving about 700,000 to 750,000 tons for these two uses. Of this tonnage rather less than one-third went for potting, and the remaining two-thirds, or say about half a million tons, for "bleaching," that is, for paper making and sizing textile fabrics.

With regard to all but special brands of china clay, their destination for "bleaching" or for "potting" is chiefly a matter of colour and of price. If a particular clay in its raw state is white enough and fine-grained enough, it will fetch a better price for papermaking than for potting. If not white enough in its raw state for making high-class paper, it may yet "fire" white at "earthenware heat" (1,230°C.), in which case it can be sold at a good price to English potteries. Even if not of good colour when fired at this temperature, it may yet burn to a fair white at the higher so-called "china heat" (1,310° to 1,350°C.), in which case it finds an advantageous market in Continental or American potteries, where the higher firing temperature is commonly used. As regards commoner clays, the bulk of the clay of low medium and better qualities is sent to the United States, where, concurrently with the demand for best clays for special purposes, there is a very great demand (at a cheaper price) for almost any grade of china clay, quite the poorest of which are, as regards uniformity of colour and of grain, superior to the domestic article produced in that country, which is not as a rule prepared or purified to free it from all traces of grittiness as it always is in England.

OUTPUT AND EXPORT.—Table I. shows for the 21 years since 1895 the output of china clay and china-stone in Cornwall and Devon. During the period of 20 years preceding the war the output of china clay increased from 439,000 tons (average of 1895 and 1896) up to 836,000 tons (average of 1913 and 1914). The exports, however, increased during the same period as shown in Table II. from 272,000 tons (average of 1895 and 1896) to 727,000 tons (average of 1913 and 1914), which is a total increase over the 20-year period of no less than 156%, or an average increase of 9·2% per annum. The domestic consumption, therefore, so far from increasing, declined from 167,000 tons to 109,000 tons, a decrease over the period of 35%. This reduced consumption is due perhaps in part to substitution of "ball clay" for part of the china clay formerly used in pottery work. The principal cause of the reduction, however, is probably to be found in the falling off of our own manufacture of pottery, and its replacement by heavy importations of foreign ware coming from Germany, Holland, Austria, and France. The transport charges on our china clay from Cornwall and Devon to Staffordshire via Runcorn are no doubt higher than the water-borne transport of our china clay to

TABLE I.—CHINA CLAY PRODUCTION FOR 20 YEARS BEFORE 1914.

Year	China Clay: Production, tons			Value	China Stone	
	Cornwall	Devon	Total	£	Production, tons	Value £
1895	367,034	57,766	424,800	252.149	55.000	22,300
1896	406,748	56.105	462,853	285.468	55 000	22,300
1897	420,681	56,512	477,193	302,783	59,713	24,311
1898	426,454	57,045	483,499	381,505	59,725	23.950
1899	451,537	52,198	503,735	299,404	54,691	21,403
1900	495.057	57,337	552,384	444,558	61,204	24,790
1901	463.504	54,064	517,568	332,310	59,923	25 074
1902	487,461	58,553	546,014	380,792	57,882	26,451
1903	490,881	55,511	546,393	362,278	53,680	21.635
1904	515,451	68,533	583,984	379,107	66,994	30,941
1905	554,893	74,267	629,160	427,140	52,171	25,515
1906	584,505	71,512	656,017	429.968	57,174	29,812
1907	639,059	75,378	714,437	478,925	68,174	35,441
1908	654,914	66,602	721,416	484,303	75,473	37,315
1909	639,939	70,441	710,360	479,753	56,028	26.352
1910	701,302	71.989	773,261	534,936	60,607	31,036
1911	713,758	73,818	787,576	537,170	61.962	28,491
1912	762 955	77,694	860,649	597.977	73,284	35,147
1913	748,788	89,863	838,651	607 890	66,6 6	32,402
1914	787,661	71,722	859,381	609,295	59,572	31,067
1915	517,759	41,745	559.504	397,761	37,112	17,411
1916	543,927	45,096	589,023	424,814	36,121	18,286

NOTE: The figures representing the output and value of china stone for the years 1895 and 1896 have been interpolated as approximate, since in the statistics published by the Home Office, no distinction is made between china clay and china stone, during the years 1883 to 1896 inclusive.

such places as Maestricht and Bonn, where there are very large and well organized potteries. Similarly the water-borne transport of the finished pottery from Germany or Holland to distributing points like London is no doubt much lower than the railway rate on such goods from the Potteries to the same distributing points. This is of course largely a question of railway rates, which, in view of the direct advantage almost always given to the foreign producer, badly need revision.

WORKING COST AND SELLING PRICES.—It would perhaps not be very useful to quote working costs and selling prices obtaining at the moment, for conditions are still quite abnormal. The output is only about one-third of the normal, and that fact alone accounts for a considerable increase in the pre-war costs, in addition to which the present high price of coal for drying must be taken into account. Similarly the present selling prices of 35s. to 65s. per ton are quite abnormal, and due chiefly to the scarcity of shipping. It will be better then to treat this question in terms of pre-war selling prices and working costs.

The working costs vary enormously, the chief factors affecting the result being as follows:

(1). Average depth of overburden that must be removed before the clay can be got at.

(2). Leanness or fatness of the clay ground;

TABLE II.—CHINA CLAY EXPORT FOR 20 YEARS BEFORE 1914.

Year	Russia	Sweden and Norway	Germany	Holland	Belgium	France	Spain	Italy	United States	Canada	British India	Other Countries	Total Exported	[illegible] £
1894	25,576	7,763	29,920	26,508	38,385	34,089	6,531	9,837	65,160			17,893	[illegible]	[illegible]
1895	23,432	7,439	34,547	25,306	40,199	32,677	6,148	7,342	86,488			[illegible]	[illegible]	[illegible]
1896	23,561	8,400	39,217	34,355	44,918	35,974	8,720	10,975	85,874	[illegible]		[illegible]	[illegible]	[illegible]
1897	28,358	8,824	37,505	34,796	47,617	40,033	11,[illegible]	9,087	94,566	Other		[illegible]	[illegible]	[illegible]
1898	31,207	12,168	39,489	38,955	45,491	41,864	7,873	9,684	9[illegible]	Countries		23,590	[illegible]	[illegible]
1899	32,191	13,167	47,327	41,977	53,099	31,849	11,778	11,709	106,193			28,268	[illegible]	[illegible]
												30,030		
1900	33,893	17,903	45,164	39,191	62,394	35,665	12,432	11,171	119,074			28,733	[illegible]	[illegible]
1901	31,995	14,591	40,825	34,216	55,974	33,785	10,890	16,076	137,932			[illegible]	[illegible]	[illegible]
1902	36,248	13,672	37,533	33,249	52,195	36,269	15,766	11,329	154,628	10,892	10,189	[illegible]	[illegible]	[illegible]
1903	36,356	13,445	42,492	43,161	55,230	40,867	11,060	12,612	156,586	10,707	9,491	[illegible]	[illegible]	[illegible]
1904	35,754	10,943	43,371	57,732	57,246	43,756	12,965	17,178	213,486	14,224	[illegible]	18,310	[illegible]	[illegible]
1905	31,741	10,585	59,003	55,008	52,274	43,615	15,039	17,304	197,336	12,234	14,072	18,929	[illegible]	[illegible]
1906	31,929	12,844	58,460	48,725	54,638	47,758	14,133	19,996	220,780	14,325	13,149	24,622	[illegible]	[illegible]
1907	40,185	12,073	69,074	67;970	56,047	47,281	13,068	16,058	233,210	17,[illegible]	11,882	25,705	[illegible]	[illegible]
1908	41,495	17,712	77,009	58,632	55,026	54,793	13,315	30,686	189,559	20,142	17,930	18,565	[illegible]	[illegible]
1909	34,839	15,964	73 216	66,572	50,538	52,682	12,311	26,404	235,109	21,042	16,519	23,030	[illegible]	[illegible]
1910	40,804	18,566	83,002	58,139	51,906	55,676	16,110	25,882	255,478	25,832	19,827	24,766	[illegible]	750,736
1911	43,640	16,139	83,091	71,018	56,111	52,628	17,695	32,975	263,008	26,218	19,455	25,754	711,166	[illegible]
1912	47,579	18,627	105,978	77,720	63,238	48,123	18,573	24,915	269,788	19,624	23,601	28,540	[illegible]	[illegible]
1913	42,648	20,746	85,806	84,540	68,221	46,860	19,987	25,636	276,377	17,363	[illegible]	31,993	732,141	[illegible]
1914	37,137	21,173	47,246	68,311	57,444	47,444	18,867	24,012	335,555	8,968	27,746	29,075	[illegible]	
1915 } 1916 }	Figures not available, returns not made in usual form by Customs Department.													

that is, the percentage of finished clay which the ground will yield, which, as has been already stated, may vary from 12% up to 50%. This factor is evidently of prime importance, since, other things being equal, the cost of handling sand and overburden must be roughly proportional to the amount of clay ground broken down and washed to yield a ton of dry clay. Generally speaking, the best quality clays are the leanest, and therefore the most costly to work.

(3). Hardness of the clay ground. Besides requiring more labour to break it up, hard ground means a thin resulting clay stream, that is to say, much more water to be pumped for a given output of clay than is required for soft clay ground, which yields for pumping a thick clay stream.

(4). Abundance and size of quartz lodes, and the presence and dimensions of barren "horses" of unaltered granite in the clay ground.

(5). The unwatering of pits by means of adit levels (as at Carclaze, Lee Moor, and elsewhere) lowers costs by the elimination of pumping, an item that varies (at pre-war rates) from 1s. to 2s. per ton of dried clay.

(6). Transport of dried clay to shipping ports is another important item, and may vary from as little as 9d. per ton, from the linhay to f.o.b., up to as much as 4s. 6d. per ton, even at pre-war costs.

Mention has already been made of the fact that the "best" quality clays often result from the working of the clay ground that is the lowest in yield, the hardest, and traversed by the largest number of barren quartz lodes. All of these features give rise to high costs of working. When producing best clays, moreover, additional items of cost often have to be considered; for instance, great care must be taken to pick out all portions of the clay ground that are at all discoloured, and set them aside for separate washing to produce a "seconds" or "common" clay. In the case of best brands of clays which have an established reputation, the necessity for this operation often precludes the adoption of the hydraulic method of washing, and so again prevents the attainment of low working costs. In many other ways, too, special precautions must be taken to prevent contamination with sand, soot, vegetable matter, and dirt of all descriptions; with this object storage tanks are in some cases roofed.

Few of the clay companies keep their accounts in such a form as to readily get at the total cost of each section of the operations, or admit of comparisons; nor indeed are the figures available for publication. Many of the items, too, are liable to very wide variations in accordance with the conditions obtaining at different pits. Upon a pre-war basis, however, the following figures may be taken as extreme variations:

	Per Ton. s.	d.		s.	d.
Labour costs	[illegible]	6	to	1	[illegible]
Coal for pumping and hoisting		4	to	2	3
Coal for drying kilns	2	3	to	3	[illegible]
Loading dried clay		3	to	[illegible]	10
Transport to f.o.b.	1	6	to	4	6
Repairs and renewals		8	to	3	4
Royalties	1	[illegible]	to	4	[illegible]
Rents, rates, and taxes		3	to	1	6

Depreciation on plant and overburden removal (average) 1s.
Establishment, agency, and realization charges 6d. to 2s. 3d.

Upon "best" clays the working costs in pre-war days may be taken at from 22s. to 26s. Upon "medium" clays expenses as a rule run somewhat lower, because deposits which yield clays of this character are, as a rule, "softer" and "fatter," with less sand and "stent" to be handled. Average figures of cost before the war may be taken at from 17s. 6d. to 20s. per ton. The so-called "common" clays are in reality of two distinct classes. One is the entire product of "fat" but discoloured clay ground, often in fact the upper portion of deposits which in depth improve and become of good colour; the other class of common clay is really in part the "mica" clay or second quality material rejected in the preparation of the best clay. The latter class of material is often in such cases of good colour, although somewhat coarse in grain, and carrying a small proportion of exceedingly fine sand and undecomposed felspar with mica. Such mica clay, being of the nature of a by-product, has no heavy labour cost upon it for mining, and can therefore be sold at a cheap rate. The average cost of production on very common clay before the war may be taken at from 9s. to 13s. per ton, the lower figure being of course that of by-product mica clays.

SELLING PRICES.—The present prices may be taken as totally abnormal, in view on the one hand of the scarcity of shipping, and reduced demand for export, and on the other hand of the restricted output. Under normal conditions, in the past, selling prices have always varied more or less with the demand from year to year, the total productive capacity of the field having been always slightly in advance of the demand. In general, prices of course vary more or less with the grade of the clay, but some of the older-established brands have acquired with regular consumers such a reputation for uniformity of colour, quality, and fineness, that they always command a price a shilling or two above that offered for equally good clays that are less well known, and the output of which perhaps is not sold direct to consumers, but through middlemen.

The period preceding the war, that is, the first 6 months of the year 1914, may be taken as typical of the state of the china clay industry under normal conditions. The dividing lines between the three grades of "best," "medium," and "common" clays under normal pre-war conditions were drawn at 24s. and 18s., all the clay sold at over 24s. being called "best," all that at less than 24s. and more than 18s. "medium," and all that below the latter figure was classed as "common."

The prices of best clays then ranged from 25s. up to 32s. 6d. per ton, the average being somewhere about 28s., against working costs of 22s. to 26s. The selling prices of medium clays varied from 18s. 6d. up to 24s. per ton, the general average being perhaps about 21s., against working costs of 18s. to 19s. As to common clays (including mica clays) their selling prices varied between 10s. and 16s. per ton, with a general average of perhaps 13s. 6d. for the common clays from the pits, and somewhat less for the by-product mica-clays.

It will be seen that before the war the average margin for profit was not very high, even on best clays, and quite low on the medium and common clays. Actual figures of profit varied within very wide limits. Thus at least two clay-pits belonging to different owners have been producing for years at a loss a particular kind of selected best clay, simply because some particular consumer insists upon having that particular clay for some special purpose, and will take no other. In order therefore to retain the custom of this client for a larger output of clay of some medium grade, upon which there is a decent profit, he is supplied also with the special brand of selected high-grade clay he requires at an actual loss to the producer of perhaps a shilling or eighteenpence per ton.

The actual margins per ton for profit to the producer varied before the war on "best" clays between a loss of 1s. 6d. and a profit of 10s. per ton; an average figure would be perhaps 5s. per ton profit. On the medium grade clays, which form the largest proportion of the total output, the margin for profit ranged from practically nothing up to perhaps 8s. per ton, an average figure being perhaps 3s. per ton. Upon mica-clays the margin for profit was always low, ranging from 8d. up to as much as 4s. per ton, an average figure being perhaps 1s. 6d. or 2s. per ton. As regards the common clays produced in quantity direct from a pit, and sold more or less in competition with by-product mica-clays from clay pits turning out high-grade clay, the question of profit or loss was chiefly a matter of situation, capital outlay, and selection of lay-out and equipment. Well-situated deposits with a large bed of "fat" clay, well equipped with suitable plant, and piping their purified and partly thickened product down to good drying kilns situated upon a railway siding within a few hundred yards of a shipping port, can always make a living profit, even if the clay has to be sold at a comparatively low price in competition with by-product clays from other works.

RESERVES.—It is not usual to thoroughly prove by test-pitting the total area of ground over which clay exists in any particular sett; usually sufficient test-pitting is done to warrant opening up a new pit, and this is afterwards worked over such area as may be warranted by the extent and quality of the clay ground, or up to the boundary of the sett. As regards their depth, too, it is not customary to "prove" or "develop" china clay deposits; general experience in the West of England goes to show that, if the area over which workable clay ground near surface is proved by shallow pitting to be large enough to warrant laying out a good-sized works, the depth to which workable clay will be found to extend will be at least as great as that to which it can be worked, at the maximum slope at which the ground will stand.

Upon even a superficial consideration of the available data, it is evident that, down to the limit of depth of the existing pumping plants, and taking into consideration only the known areas that have been tolerably well mapped out, there is china clay of good grade in sight in the West of England for at least a century at the pre-war rate of output. Since the deposits extend down to unknown depths, none having been really unbottomed, the available reserves are in fact very much greater.

CHINA CLAY LEASES.—The usual conditions under which leases are granted to work china clay lands include payment of a royalty per ton, and of a minimum rent which merges in the royalty. Based, originally, and in theory, upon the supposed quality of the clay, neither bears in practice any relation to the probable profit that can be realized from the particular piece of ground involved, being generally fixed rather in accordance with the custom of the estate (or in exceptional cases by the degree of anxiety shown by the original applicant for a lease) than with any reasonable anticipation of probable results. The leases usually, though not always, include a rate of compensation for surface damage, that is, for land occupied by buildings, works, waste heaps, etc., and frequently also a clause by which the whole of the buildings and permanent works revert to the lessor at the end of the lease, and he is even entitled to take over the machinery at a valuation.

Considering first the comparatively minor matter of surface damage, for so-called cultivated land (which is as a matter of fact generally poor pasture land) from £60 up to £160 per acre is often charged. As to moorland (in which category may be classed most of the land in the vicinity of clayworks), this also is sometimes charged for at £30 per acre. More often, however, no charge is made for such land, which indeed is only reasonable, considering that its utmost annual value for rough grazing is only about half-a-crown per acre.

Minimum rents vary from £50 up to as much as £2,000, and seem to bear little or no relation, either to the total area involved, or to that which has been proved by pitting to contain clay. Under a liberal-minded landlord, one large area is leased at a minimum rent of £50; for others, smaller in extent, and far smaller in their possibilities, a grasping landlord or his agent fixes a minimum rent of £600 to £1,000. Although the minimum rent merges in the royalty, some of the amounts fixed are so large, in comparison with the extent of workable clay and the scale of operations, that it is only possible for the royalty upon tonnage to cover the minimum rent when the plant is working nearly up to full capacity. At times of depression, or of slack demand for the particular quality of clay produced, the royalties often fall short of the minimum rent payable.

Since 1914, in consequence of the war, of lessened demand for paper, of the closing of markets, of high freight rates, of scarcity of shipping, and of shortage of labour, the total output of china clay has declined to about one-third of the pre-war total; and is only slowly increasing as some of the above disabilities are removed. In many cases, therefore, the amount of royalty payable on the output has not been sufficient to cover the minimum rents. Some landlords have, under the circumstances, met their lessees, accepting in full discharge of their claim for minimum rent the actual amount of the royalty payable. Others again have insisted upon their legal rights, and give receipts "on account" for the amounts of royalty actually accrued and tendered, calling upon their lessees to put their hands in their pockets to pay the full £600 to £1,000 of minimum rent specified in the lease. In some cases, indeed, payment of heavy minimum rents has been demanded even when all working of the property has been suspended during the war. Such action presses hardly upon lessees who invested perhaps £15,000 to £25,000 shortly before the war in developing the property, and who, owing to the reduced scale of operations possible under war conditions, have made a loss instead of a profit.

Leases are usually granted for 21 years without option of renewal. When the lessee applies for extension or renewal (which is often refused by the landlord's agent until within five years of the expiry of the lease), a new lease is rarely granted without a demand for an increased rate of royalty, or for a "fine" of £500 to £1,000.

Royalties vary from a minimum of 9d. upon mica clays up to 4s. 6d. per ton, and in their incidence are most capricious. One works may pay a reasonable rate of royalty of only 1s. or 1s. 6d. per ton; other works, producing clays of similar quality, and perhaps not nearly so well situated, have to pay royalties of 3s. to 4s. per ton; figures which in some cases are larger than the net excess of revenue over expenditure, without taking into account any allowance for amortization (which upon the basis of a short lease should be fairly high), or for interest on the capital invested, or for remuneration to the owners for their services in managing and carrying on the business, most of the concerns being private firms or small private companies.

To the landlords who have received fixed royalties upon tonnage regardless of selling prices and of working costs, the clay business has been exceedingly profitable. One fortunate landlord is said to have received regularly during recent years £30,000 per annum, and the total amounts received from china clay in Cornwall and Devon during 1913 and 1914 must have been near £120,000.

It has been estimated that the profits realized out of china clay by the landlords in the form of royalties and minimum rents during the past 30 years are at least as great and probably greater than the total profit realized by the operators or lessees, most of whose profits have indeed been put back into the industry in the shape of enlarged buildings and plant, in order to turn out a steadily increasing output, and who have indeed created the industry by their enterprise, extending in several cases over three generations.

The fact that none of the landlords' profits ever return in any form to the industry is not complained of by lessees. The following, however, are real grievances:

(1). The entirely arbitrary character of the minimum rents, which appear in some cases te be based upon no consideration other than the caprice of certain landlords or of their agents.

(2). The unequal incidence of royalties, which are not calculated upon any uniform basis, nor do they take into consideration either the value of the clay available or the probable cost of getting it.

(3). The fines demanded upon renewals of leases, the onerous reversion clauses sometimes introduced, and the antiquated minatory covenants often inserted, which, if not intended to be enforced, would be far better omitted.

Some landlords, and some of the agents, deal with their lessees in a fair spirit, and seem to realize that no return can be equitably expected by the landlord, who has risked nothing, unless the lessee, who risks his capital and provides the business experience, gets some return for both. On the other hand, several instances could be quoted of grasping or unfair treatment on the part of certain other landlords or their agents. It would seem that an industry of such national importance ought not to be at the mercy of arbitrary action on the part of land-owners, or subject to glaring irregularities in the incidence of royalties and minimum rents, and that some form of compulsory arbitration and control as between lessor and lessee is desirable in the interest of the State.

FOREIGN COMPETITION.—It is commonly supposed that china clay is a natural product peculiar to Cornwall and Devon, and not found anywhere else in the world. On the contrary, a material having similar composition and physical properties has been found and is being actually produced at many places in France, Bohemia, Saxony, Bavaria, Denmark, Sweden, Russia, Spain, and other parts of Europe and Asia, as well as in many parts of the United States. Some of the deposits in France, Bohemia, Denmark, and Spain resemble the Cornish, in that they are decompositions of granite *in situ* associated with mineral veins; a great many, however, appear to be kaolinization *in situ* of beds of gneiss, or dykes of porphyry and other felspathic rocks; others are secondary accumulations of detrital character. As regards quality, a few of the former class, particularly in Bohemia and some of those in France and Saxony, yield washed products quite equal in quality to the best Cornish china clay; the deposits, however, do not appear to be capable of being worked so cheaply as ours.

As regards American so-called kaolins, large quantities appear to be available in many states, particularly Alabama, Georgia, North and South Carolina, Maryland, Pennsylvania, and Vermont. They are, however, all detrital, and their mode of occurrence is, like that of the Bovey Tracey ball-clays, in beds between beds of sand or rock, from which the clay is simply dug and sold, in some cases without any purification or mechanical preparation.

Even when "blunged," or beaten with water to form a pulp, the separation of gritty particles is effected only by means of wire screens of 100 mesh, followed by others of 200 mesh made of silk. In view of the liability of all screens to form holes, it is obvious that, even if the colour and composition of the clay were as good as the Cornish, which it is not, uniformity of fineness cannot be so well secured as by the Cornish system of settlement; nor is it possible to secure the same uniformity of colour and of composition by such methods as by the Cornish system of combining several washing streams in one general settlement system, in which large quantities are in course of treatment, so that any slight variations compensate each other. The American clays, too, almost always contain much more iron and titanium than ours; these constituents unfavourably affect the colour, not only in the raw state, but also when fired. They are, moreover, only partly removable by acid or other treatment, so that even the most careful preparation and purification does not yield so satisfactory a product as our own.

The chief peculiarities about the West of England output of china clay, to which its preeminence is due, are the following:

(1). Large size and convenient situation of the deposits close to surface, and extending over wide areas, which gives them facilities for cheap working, and warrants the laying out of treatment works upon a large scale.

(2). Careful preliminary preparation, which secures uniformity in composition of the product sold under any given brand to a degree nowhere else attained, save perhaps in Bohemia.

(3). High average quality and good colour of the clay, as compared with the average quality from any other district. The "best" West of England china clays cannot be challenged in this respect by any of the foreign clays, except the best Bohemian.

(4). Proximity to shipping ports, and the convenient geographical situation of Cornwall, which offers facilities to outward-bound ships for loading rapidly a material that makes better ballast than either coal, sand, or water.

Rather than any unique character possessed by our West of England china clays, it is these natural advantages that enables even the commoner qualities of our clay to be exported to foreign ports, such as those of the United States, where they are largely used for papermaking in consequence of their superior quality, together with the fact that the rail-transport charge upon them from seaboard to the great papermaking centres of the Northern and Middle West States is no greater than that from the Southern States, where only are produced clays of more or less similar character, although generally inferior in quality. Similarly, within certain limits of price, our seaborne clay can compete in Continental markets, owing to the distance by rail between the foreign centres of production and of consumption. Before the war, for instance, large quantities of our clays were used in the pottery and porcelain factories at Maestricht and Bonn, in spite of active competition from Bohemia, Bavaria, and Saxony.

As regards "best" and "superior medium" grades of both "bleaching" and "potting" clays, the position is even more favourable. Foreign consumers are prepared to pay a high price for our clays, because no china clays of such uniformly high character are produced upon a commercial scale anywhere except in Bohemia. Best bleaching clay before the war was sent all the way to Dresden for use in papermaking in competition with the best Saxon clays; these, although largely used for pottery and porcelain at the Royal Dresden and Meissen potteries, would seem to be inferior to ours for papermaking, probably on account of their coarser grain, as well as slightly inferior colour in the raw condition.

Prospects of the Industry.—The extent of the demand for our high-grade china clay is instanced by the fact that the total shipments to the United States (mostly of medium-grade clay), which had gradually increased in the 20 years 1894 to 1914 from 65,000 tons to 335,000 tons, only fell off in 1916 to 220,000 tons, in spite of the fact that ocean freights went up from about 11s. to 12s. 6d. in 1914 to 35s. to 45s. in 1916, an increase of nearly 300%, which practically doubled the cost of the material to the buyer on the other side. At present, of course, sale prices are so much higher on this side that the cost of best clay to an American buyer is practically three times what it was before the war. It seems to the writer probable that so great an enhanced cost, if maintained for long, will not only preclude the consumer from increasing his consumption of the high-grade imported clay, but will induce him to curtail it as far as possible, substituting for it domestic products even if of inferior quality. Not only so, but it may force him to direct attention to improved methods of preparation, whereby the quality of his domestic products will be improved, as well as to search closely for new sources of domestic supply, which in the end may be found to be as good as our own. It is unwise to risk killing the goose that lays the golden eggs. Up to a certain point, however, it may be said that our West of England china clay holds a world's monopoly for uniformity of quality, and can therefore count upon a large and steady demand in foreign markets at prices considerably higher than those which have ruled up to date. The low prices realized in the past have resulted from slight over-production, combined with ruinous competition and reckless cutting of prices by a number of small and weak producers, lacking in financial resources, and fearful lest the market demand should not suffice for all.

A great disadvantage under which the industry has always laboured is the fact that, deposits of clay being plentiful, and the amount of capital required to start a small shallow works being not large, small private companies have been continually coming into the business with insufficient financial resources, and selling to the agents of middlemen in a large way of business inferior "top" clays, the cost of production of which was low, at but little above cost price. The middlemen were then able to place these clays at a good profit, substituting them for established brands of medium quality. Although the highest-class clays have not been affected by this competition, such continual under-selling on the part of the smaller and weaker producers (many of whom from time to time have gone to the wall) has forced down the general level of prices to far below that which the foreign demand for our china clay would have stood without the slightest risk of curtailment. Profits in consequence have remained at a level which must be considered low, in view of the lack of serious competition from outside, and of the importance of the turnover.

It was chiefly a recognition of this fact, combined with the falling off in demand, and the increase in working costs caused by the war, that brought about the formation of the association of producers under the title of "Associated China Clays, Ltd." The function of this Association is to grade all clays and fix the standard value of each brand according to its quality, regulating all contracts of sale, to the extent that no producer belonging to the Association may sell below the standard value fixed for his product, estimating from time to time what is the total quantity of china clay that can be advantageously disposed of, and assigning to each producer a certain percentage of his maximum output in accordance with his total drying capacity. Such an Association is a boon to the industry, since it saves the weaker producers from throwing their output upon an already overburdened market at times when demand temporarily slackens, and brings stability all round. The only danger is that, if not handled with sufficient judgment, the Association might concentrate all efforts upon marketing its product to the best advantage by securing remunerative prices, to the extent of restricting demand. In regard to this point, however, the composition of the board of directors, which includes representatives of the smaller producers as well as of the larger, would appear to be sufficient guarantee. While undertaking research and experiment with the object of improving existing methods of working, it is the policy of the Association to cope with increased market demands as they arise, by pressing to the economic limits the output from existing pits and works, rather than by opening new ones; this should lead to the best possible conservation of the national resources, and is therefore in the national interest.

(To be concluded).

LETTER TO THE EDITOR

McElroy's Formula for Azimuth.

The Editor:

Sir—In a recent issue of the Magazine, Mr. Alexander Richardson referred to the McElroy formula for calculating azimuth. I agree with him that this formula is not so widely known as it deserves. I should like to give a detailed description of its form and use in the slightly modified shape in which I have employed it in my own practice.

As given by McElroy, the formula reads:

$$\text{Cos Azimuth} = \frac{\text{sin dec}}{\text{cos lat cos alt}} - \text{tan lat tan alt}$$

I do not suppose there is one of your readers not occupying a professorial chair who can quote off-hand the formula given in the text-books and generally used for computing azimuths. Some may remember in a hazy way that declination has to be subtracted from 90°, the result added to latitude and corrected altitude, this result halved, and from it subtracted in succession the latitude, corrected altitude, and the complementary declination, these results and the halved one all multiplied together, then the square root of the result extracted and the value of the tangent of the angle which corresponds to this figure looked out, and then the angle doubled to give the celestial body's azimuth from the pole, sometimes the north and sometimes the south.

McElroy's formula saves *delay* and this fact provides a simple mnemonic for remembering it. The trigonometrical terms are written in the order in which one naturally speaks of them, sine, cosine, and tangent.

The elements of the celestial spherical triangle in the fractional part of the equation are written in the order of the sounds in "delay"; sin D, cos L, cos A. The last term of the expression consists of the last of the trigonometrical functions (the tangent) applied to the elements occurring as the denominator of the fractional part of the equation.

All this may sound rather fanciful, but as the reader is not likely to have a copy of the Michigan Engineers' Handbook for 1889, and will not find the formula hardly anywhere else, it is just as well to commit it to memory. Peele's Handbook gives the use of the primary spherical trigonometry equation, but this lacks much of the simplicity of McElroy's.

My modification consists in employing the secants of the latitude and altitude instead of the sines, so that in the logarithmic computation of the first part of the equation the logs of all the functions can be added, instead of adding first the logs of the cosines and subtracting the total from the log sin of the declination. The formula then reads:

Cos Azimuth = sin dec sec lat sec alt − tan lat tan alt.

I give an example of its application. Obserservation to determine magnetic variation December 25, 1910. Star observed: Betelgeuse. Declination (North) 7° 23′ 30″ (from Nautical Almanac). Altitude (mean of observations of both faces) 46° 26′ 30″. Correction for refraction and temperature 0° 1′ 00″. True Altitude 46° 25′ 30″. Latitude (scaled from map) N 10° 7′ 00″. Reference angle 99° 54′ 00″.

Sin dec	7°	23′	00″	9·108 9272	
		diff	30″	4869	
Sec lat	10°	07′	00″	0·006 8054	
Sec alt	46°	25′	00″	0·161 5131	
		diff	30″	664	
				9·277 8080	0·18958
Tan lat	10°	07′	00″	9·251 4612	
Tan alt	46°	25′	00″	0·021 4851	
		diff	30″	1264	
				9·273 0727	0·18753

Nat. cos Azimuth of star from pole				0·00205
Azimuth of star from pole	89°	53′	00″	
Reference angle..............	99°	54′	00″	
Magnetic variation	10°	01′	00″	

It will be observed that all differences for seconds are added, a great convenience. I have used Chambers's Tables to bring this point out clearly. Values of secants are unfortunately not usually given in shorter tables, but can easily be set down by reading the cosine values and setting down the amounts by which each individual figure differs from 9, and this can be done quite easily from the left. I have made a doubled solar observation and computed the result in 20 minutes by the above formula. As regards accuracy, I have checked it against text-book examples where the values of the elements are given to the second place of decimals in the seconds, and found it quite accurate, in fact more accurate, as in the ordinary old-fashioned way the necessary gymnastics give decimals to the third place, which being disregarded slightly affect the final figures.

North latitudes and declinations are regarded as plus, and south ditto as minus. The algebraic rule is followed in subtracting the second factor from the first, but I need not go into minutiæ, as the treatment of the resulting azimuth with regard to the reference line is usually obvious, and is not affected by the choice of a formula. The zero of the vernier on the horizontal plates was set with the needle at zero in the above observation, and the reference angle obtained by noting the reading on the horizontal circle at each observation, and averaging.

I do not think it has been pointed out before, but the same type of formula can be used for determining local mean time, and while an extra meridian observation is being made for azimuth it is very little trouble to note the watch time of observations and so find the actual error of the watch from local mean time.

A star being regarded as the radium-tipped hand of a gigantic watch, it is easily remembered that its altitude in the heavens is the determining factor in obtaining the time, so that altitude must now be put in the most important position in the formula, which will now read:

$$\text{Cos Hour Angle} = \frac{\text{sin alt}}{\text{cos dec cos lat}} - \text{tan dec tan lat}$$

The formula is in exactly the same shape as before, except that declination and altitude have changed places. The secant modification can be used here also. The star's right ascension must be known, and the Greenwich sidereal time of Greenwich mean noon. The latter should be corrected for difference in longitude, but the correction is so small as to be hardly necessary, and anyhow the longitude need only be known approximately. The correction gives the Local S.T. of Local M.N. and usually differs only by a fraction of a second from the Greenwich figure given in the Nautical Almanac. But I need not describe the general routine of a computation.

R. T. Hancock.

Jemaa, Nigeria,
October 20.

NEWS LETTERS.

CAMBORNE.

STRIKE AT SOUTH CROFTY.—The vexed question of unionism versus non-unionism is again to the fore, this time at South Crofty mine, where the whole of the underground operations are suspended in an attempt by the members of the Workers' Union to coerce one man to join that organization. At the end of the year there were quite a number of the company's employees who were not members of the Union, but by peaceful (?) persuasion, all were forced to join, except one stalwart who remained adamant. He appears to be one of the pumping-engine drivers, and as he was known to be coming on afternoon shift, it was decided to serenade him with a meeting outside the engine-house. When the meeting was over, and the local organizer went to ascertain the effect of this fearful blandishment, he found that the man was more determined than ever to remain outside the Union, and he added that if the Company's officials tried to force his hands, he would send in his notice. For a number of days over 400 men are idle in this attempt to force one man to join an organization which he did not wish to do, and yet these self-same men object themselves to be conscripted in the service of the State. We believe that the co-operation of employees in Unions has in many instances materially assisted them to secure better pay and conditions from unscrupulous or unthinking employers, and to that extent they serve a useful purpose, but when, as in this case, they unreasonably attempt to blackmail or force anyone to join, they should be resisted to the uttermost, and the State should give the necessary protection. What an outcry there would be if an employer refused to employ a man belonging to a Union.

TIN TICKETINGS, 1919.—The quantity of tin concentrate (crop and slime) offered for sale at the Ticketing last year amounted to 2,858 tons, and is estimated to have realized the sum of £366,569, or an average of £128 5s. per ton. It will be recalled that the three principal sellers, East Pool, Dolcoath, and South Crofty, suspended sales by this method at the end of September last, so that no useful purpose is served in giving for comparison the sales by this method in past years.

KILLIFRETH.—It is reported in the Press that a further sum of £20,000 has been provided as additional working capital, but if this is true, the money must have been subscribed as a loan or in the form of debentures, as the whole of the existing share capital has been subscribed, and no increase in capital has yet been authorized. It will be recalled that at the time the company was formed, we expressed doubt as to the adequacy of the subscribed capital. However, the prospects of the mine are quite good, and we understand that arrangements have been made to lease the battery on the adjoining derelict Gt. Wheal Busy property, so that the ore already disclosed or developed may shortly be converted into cash.

GRENVILLE.—We are glad to notice that payable tin ground has been located on the North lode at the 80 fm. level from Goold's shaft in the western section of the property. The present manager, J. Nile, who was previously the chief underground agent, has, we believe, long held the opinion that this western section of the property, abandoned forty years or so ago, was deserving of attention, but the old management preferred to concentrate on the Great Flat lode in the deeper workings. We hope the exploration of these shallow workings will justify his belief. It is quite evident that the pumping equipment will need to be considerably overhauled before any extensive development can be carried out in the deeper levels. It is a matter of satisfaction that at last a technical man has joined the board in the person of Mr. H. G. Payne; we have long pointed out in these columns that the company has sadly suffered in the past for an entire lack of sound technical advice and direction.

TREBURGETT CONSOLIDATED MINES, LTD.—This company was formed in February last to acquire and reopen the Treburgett silver-lead mine, situated at St. Teath, Cornwall. The nominal capital is now £25,000, and the public have recently been invited to subscribe £10,000 in shares of 5s. each at par. From the prospectus it would appear that the adit has been cleared, and the main shaft repaired and equipped with pumping and winding machinery. The money is required for pumping out the mine, and presumably for the provision of dressing and other plant. Although the workings below adit are still under water, and to judge from the absence of assays, no information is available of the ore in sight or its value, the consulting engineer has had the temerity to figure out the weekly profit which may be anticipated, and the directors express their confidence in "large dividends." It may be that with silver and lead at present prices the reopening of this mine may be justified, but to estimate profits without development or accurate data is a reprehensible course which has before brought discredit on Cornish mining. We notice that the consulting engineer, Dr. J. B. Garbe (who, we believe, was previously associated with the management of Wheal Vincent at Launceston), styles himself "A.M.C.G.M.," whatever these letters may represent. Can any reader solve the mystery of these letters?

TIN FLOTATION.—Minerals Separation has come to an arrangement with the directors of South Crofty to erect at that mine an experimental unit of plant for treating the company's ore by flotation. It will be recalled that Minerals Separation's efforts failed at the Killham mine, St. Neot, and that their further effort at Carnon Valley was equally unsuccessful. No doubt the promising result secured with a flotation process at East Pool referred to in the last issue has spurred Minerals Separation to fresh effort, which, needless to say, in the interest of the industry, we wish may prove successful.

ELECTROLYTIC COPPER REFINERIES IN DEVON.—Recently a bill to secure parliamentary sanction to the employment of water from çertain Dartmoor streams with a view to the production of electrical energy and current has been lodged at the private-bill office. While it is proposed to supply power to the surrounding towns and villages, the principal object of the promoters, as stated in an interview with Mr. H. J. Wilson as recorded in the *Western Morning News* of December 17 last, will be to operate in this country an electrolytic refinery, the raw material of which is blister copper. This process is entirely innocuous to the district in which it is operated. The capital of the company is £1,250,000, and it is interesting to note that Sir Gerard Muntz is one of the directors.

LEVANT MINE.—The recent disaster at this mine has at last made the adventurers face the question of the necessity for providing a large sum of money for development and equipment on modern lines. As was to be anticipated, the large sum required, estimated by Mr. H. F. Collins, who recently inspected the mine, at no less a sum than £100,000, was beyond the willingness of the holders of the 2,500 shares in this Cost Book Company—the last of any consequence operating within the Stannaries of Cornwall and Devon—for it meant a call of £40 per share, spread over the next year or two. Here we have an excellent instance of the unsuitability of the cost book system for financing large undertakings, and, too, it may have been an example of how many sound mining propositions in Cornwall have been wrecked in the distant past, when this system was much in vogue. Fortunately, in this instance there were capitalists who were willing to come to the rescue, but had these circumstances arisen at a time when money was hard to find, or on a falling tin market, this mine, probably one of the oldest and richest of the tin mines of Cornwall—and yet one with still the best of prospects—might have suffered the fate of many another property forced to close in the past, not because its mineral had been exhausted, but by reason of the fact that under the cost-book system no financial reserve was ever created and the adventurers were unequal to meeting a large demand on their pockets. This famous mine will this year have been in known continuous operation for a century, and it was doubtless good news for the St. Just community that Messrs. Oliver Wethered and J. Vivian Thomas were willing to come to the rescue and find the capital, not only to pay the company's debts, but to equip and develop the mine on a scale worthy of its past. The shareholders have now agreed to sell as and from January 1 the mine and plant to a new company to be formed, having a nominal capital of £160,000 in shares of 10s. each. The purchase consideration will be £20,000 payable in fully paid shares of the new company, so that each share in the old adventure will be exchanged for 16 in the new. In addition, the new company will pay £9,000 in cash to pay off liabilities and other small sums to meet certain incidental expenses. Messrs. Wethered and Thomas guarantee the provision of £60,000 working capital, and 80,000 shares will be kept in reserve for issue should further monies be required, as may reasonably be anticipated will be the case. It would appear that a large portion of this capital will be provided by Geevor Tin Mines, Ltd., the company operating the adjoining properties, although not working on the same lode series. As we pointed out in the last issue, the Geevor company has recently made an issue of capital which provided £135,000, so that it was in a position to guarantee funds for Levant forthwith. It will be an excellent thing for the district that Geevor and Levant are to be under the same control, and we congratulate Mr. Wethered and his colleagues on their farsightedness in acquiring for a reasonable figure a property which is more than likely to handsomely respond to the programme of development which we are confident they will see carried out. Major Freethy Oats will still be associated with the mine in the capacity of a director of the new company, so that his long knowledge of the property will be available to the new owners

NORTH OF ENGLAND.

As the North-Western district, up to the present time, has been the principal source of supplies of zinc concentrates in the United Kingdom, it may be of interest to see the proportion of output that has been obtained here. I give below the figures of output from the different mines for the past few years, with the United Kingdom output. From this it will

OUTPUT OF GALENA FROM NORTH-WESTERN DISTRICT COMPARED WITH UNITED KINGDOM OUTPUT.

	N.W. District Tons	United Kingdom Tons	Percentage
1912	3,168	25,409	12·4
1913	3,848	24,282	15·8
1914	3,103	25,988	11·9
1915	1,974	20,697	9·5
1916	2,018	17,083	11·8
1917	1,544	15,322	10·1
1918	1,919	14,765	13·0

OUTPUT OF BLENDE FROM NORTH-WESTERN DISTRICT COMPARED WITH UNITED KINGDOM OUTPUT.

	N.W. District Tons	United Kingdom Tons	Percentage
1912	11,789	17,704	66·3
1913	13,730	17,294	79·3
1914	11,366	15,149	75·0
1915	5,749	12,057	47·7
1916	4,587	8,475	54·1
1917	4,149	7,487	55·4
1918	5,755	8,860	64·9

be seen what a serious position is created by the complete suspension of all Government assistance.

The mill and dressing-floors at Vieille Montagne at Alston are now stopped, and all work is at present confined to the Nentsbury section of the property, which is, of course, a very small one. As far as I can learn, the Vieille Montagne are still considering what is best to be done, and, of course, the report of the Commission may lead to such an improvement in the situation that it may be possible to resume operations on the large scale that previously obtained. The only other producer in the Alston district is Cashwell, but the operations there are on a very small scale. On the west side of the Pennines some work is being done at Silver Band mine, but as the whole of the lode gangue is barytes, this mineral is at present having preference. The engineers of this latter company are facing the problems of transport by the consideration of a scheme for the erection of a long ropeway. The cost of horse carriage is prohibitive. In this district man and horse are costing 17s. to 18s. per day; and in the case of Silver Band, one journey per day with a light load is all that is possible. The installation of ropeways may solve some of the serious difficulties of transport in these isolated districts. At Longfell barytes mine, near Appleby, there is a very fine equipment which is worked by gravitation. It is about a mile and a half long. Without it the barytes deposits would be absolutely worthless even at present prices. The gypsum deposits in the Eden valley are being worked with great vigour, and steps are being taken to open out new areas.

There has been a serious breakdown at Thornthwaite caused by the bursting of an air vessel. The repairs were effected by means of oxygen-acetylene welding, and the pumping plant is now at work again, but the mine will not be clear of water for some time, and the stoppage of output represents about one month's production. The hydraulic pressure at this mine is 240 lb. to the square inch. The air vessel at the shaft, which had a margin of safety of 20 to 1, was installed for the purpose of taking up the shock on the pipes caused by the intermittent supply of water to the pumping engine. The variation of pressure in the pipes was about 40 lb., and the size of the air vessel was 10 ft. high by 3 ft. in diameter, and was made of mild steel nearly $\frac{3}{4}$ in. thick. The top of the cover of the vessel had originally been welded on by electricity and tested to 1,000 lb. without showing any signs of deflection. It is probable that during the eight years which it has been working a nearly imperceptible movement, due to variation of pressure, must have developed fatigue at the joint (electrically welded on). The whole top, weighing about 2 cwt., was blown off and projected nearly 200 yards up the fell side. A careful examination showed crystallization at this joint. This metal was cut away, the top was welded on, and heavy straps welded right across the cover. At Thornthwaite the oxygen-acetylene welding has been used for many years in repairs to castings, engines, tables, and other things. Now that spares are so extremely difficult to obtain, this form of repair is worthy of consideration. In no case has any casting broken again at a place where repairs of this kind have been effected.

With regard to the general position, the price of lead (£45) has now reached a figure that makes it possible to work a mine at a profit, and the lead mines in this country should have no difficulty in meeting their costs and making a profit. The claim for a bonus on the production of lead ore was dropped by Mr. Onslow and Mr. Anthony Wilson when they were giving evidence before the Non-Ferrous Commission. With respect to blende, some assistance will undoubtedly have to be given as long as the Australian concentrates are hanging over the market. Smelters are still offering £8 at Swansea, but a further rise in spelter is inevitable. The price must surely rise to at least £60 a ton before the English smelters can give a price for zinc ore that will cover the cost of production. On the Continent the works are rapidly recovering from the war devastation, and when the present stocks of blende are exhausted there must be an active demand from Belgium and Germany. It is difficult to form any estimate as to when the shortage of zinc concentrates will show itself, but within two years the market will be practically depleted of supplies unless the price rises very considerably.

The Non-Ferrous Mining Commission is in the middle of the evidence given by the representatives of the lead and zinc mines. The whole case for the industry has been presented by Mr. Onslow and Mr. Anthony Wilson. The investigation seems to be very thorough. The only hope of direct temporary assistance will be in the form of a subsidy on the production of zinc ores for a comparatively short period. The case for the completion of schemes inaugurated by the late Mineral Resources Department seems irresistible, and it is difficult to see how the Commission can possibly fail to recommend the provision of capital for the extension of schemes like the Halkyn drainage tunnel. The future of the lead and zinc industry, in fact of all mining in this country, must depend to some extent upon the removal of the disabilities which it suffers from taxation. I have seen some of the figures that have been laid before the Commission relating to taxation, and it is perfectly clear that something must be done to remove the injustices under which it labours. There is of course no provision under the existing taxation system for the extinction of capital items representing the depletion of mineral deposits except out of taxed profits. The position on the Rand has been met by a tonnage charge which is placed against working costs. In the United States a similar method has been adopted, and the Treasury officials there asked the mining industry to meet them with a view to a full discussion of the best methods of their arriving at an equitable method of taxation. Would it not be possible for the Government to have a conference with the non-ferrous mines respecting this most vital question?

The situation at Mill Close mine, in Derbyshire, is decidedly interesting. The mine is being run by non-union labour and the results are quite satisfactory, there being a considerable output of galena. The men who went on strike still adhere to their claim that no man must be employed at the mine who is not a member of the Derbyshire Miners' Union, and the company cannot give way unless they are prepared to dismiss the substantial section of non-union labour. The men on strike have taken the bold step of acquiring a mining area which they intend to work themselves, with the aid of Union funds. They are starting work with lead at a very high price, and the progress of this venture will be watched with great interest. The industry will welcome the addition of a new factor in its organization.

TORONTO.

December 12.

COBALT.—Production has been greatly stimulated by the high price of silver, which has given a new life to many old mines that were regarded as being worked out, and rendered profitable the treatment of several million tons of tailing and rock formerly thrown aside as waste. The high wages paid under the bonus system based on the price of silver has secured an adequate supply of efficient labour. The Nipissing during November mined ore of an estimated value of $350,209, and shipped bullion from Nipissing and custom ore of an estimated net value of $593,633. The Mining Corporation of Canada has purchased a controlling interest in the Buffalo mine, one of the old-time producers. The workings of the mine will be connected with those of the Cobalt Lake property of the company, and the ore treated in its mill and the sand pumped from Cobalt Lake will be subjected to regrinding and treated by the oil flotation process at the Buffalo mill. The Northern Customs Concentrator has purchased 25 acres of the property of the Chambers-Ferland, containing a large tonnage of low-grade ore, which the latter company, not having a mill, was unable to mine profitably. The transaction places the Chambers-Ferland in a financial position enabling it to carry on extensive development work on a promising area lying between Nipissing and La Rose. The Crown Reserve has encountered a high-grade vein 4 in. wide at a depth of 150 ft. The Beaver Consolidated has considerably improved its position by recent discoveries of high-grade ore on the 200 ft., 600 ft., and 700 ft. levels. The Lumsden mine, which was operated in the early days of the camp with limited success, has been taken over by C. L. Campbell, and is being examined preparatory to development. The payment of a 3% dividend by the

McKinley-Darragh on January 1 brings the total returns of the company to shareholders up to \$5,686,735, or 256%. The Peterson Lake mill is working on ore from old dumps. Funds have been obtained by the sale of Treasury stock, and the workings are being unwatered preparatory to an active exploration campaign. A ball-mill has been added to the mill equipment. The Kerr Lake has put into practice the proposed system of workmen's committees, consisting of their own employees only, to discuss labour conditions with the management.

PORCUPINE.—The shortage of labour is still a serious drawback to activity in this and other gold-mining centres. The silver mines and lumber operations are paying higher wages than the gold-mining companies can afford to give, and the working forces are much below requirements. The Hollinger Consolidated is using mechanical shovellers successfully. The company is piling up a good surplus, but it is understood that the expectations which were largely entertained that the old dividend rate of 1% per month would be restored in January will be disappointed, as the directors are determined on maintaining a conservative policy. The declaration by the Dome Mines of a 25 cents per share dividend, payable January 15, has caused much satisfaction as an indication that the gold-mining industry is recovering from the economic depression caused by the war. The closing down of the mine resulted in a loss of \$455,456 during the year ended March 31 last, and practically exhausted the surplus, and the dividend disbursement is the result of the last half-year's activities. The McIntyre is pushing development at the 1,500 ft. level, the deepest working in the district, where an ore-body 7 ft. in width is stated to carry ore averaging \$10 to the ton. The Morreta is being sampled on behalf of the Porcupine Crown, which will take over the property if the result is satisfactory. At the Keora a shaft is being sunk on a vein proved by diamond-drilling and stated to carry very high-grade ore at depth.

BOSTON CREEK.—The central shaft on the Miller Independence has reached a depth of 350 ft. Lateral work will be done at the 400 ft. and 500 ft. levels to cross-cut a large ore-body developed in an inclined shaft. The delay in installing electrical equipment, which retarded operations for some time, has been overcome, and work will now be speeded up. Diamond-drilling on the Boston-McCrea has encountered some promising veins at depth. The Ivanhoe-Boston, a new company, has acquired a group of claims lying northeast of the Patricia, and arrangements are being made for starting development. A steam-driven plant is being installed at the Peerless (formerly the Mondeau). The Hughes claim lying north of the Peerless has been taken over by a new company known as the McElroy-Hughes.

KIRKLAND LAKE.—A good deal of new capital, mainly from Buffalo and Chicago, is seeking investment in this area, where a number of new prospects are being developed. The Lake Shore has been unwatered to the 300 ft. level, and operations are in progress in the upper workings. During November, 570 tons of ore was milled for a production of \$10,246. The December output will be close to normal. The Granby-Kirkland has completed the construction of buildings. Five veins have been found, on one of which the sinking of a shaft has begun, the vein widening to 8 ft. a short distance down. The Kirkland-Combine, controlled by Chicago interests, is installing a plant and will shortly begin sinking. The Kirkland Lake mill is operating at capacity, treating 150 tons of ore per day.

GOWGANDA.—This district is attracting a good deal of attention owing to the heavy production of the Miller Lake-O'Brien, which is meeting with excellent results at a depth of 460 ft., and the success attendant on the development of the Castle property by the Trethewey company. The latter is preparing to make a shipment of high-grade ore. The silver extracted at the Miller Lake-O'Brien is stated to be almost pure metal, but as the company is a close corporation, no details are given out. The Walsh property, on which the Crown Reserve, of Cobalt, held an option, has been allowed to revert to its original owners, by whom operations are being resumed. A large ore-body on the 200 ft. level carries both high and low-grade ore. The Miller Lake Silver Lode, adjoining the Walsh, has been optioned to Montreal interests. The mill of the Reeves-Dobie is in operation, producing \$1,000 per day. Preparations are being made for the development of electric power at Indian Chutes, on the Montreal river, to supply Gowganda and Matachewan.

WEST SHINING TREE.—The shareholders of the Wasapika have ratified the proposal of the directors for a consolidation of the company with three properties lying to the north. A new company will be organized, capitalized at \$6,000,000, to be known as the Wasapika Consolidated, each stockholder in the present company receiving three shares for every share of the old stock.

PERSONAL

H. W. ADLER has been appointed manager of the City & Suburban mine.

WILLIAM BACK has left for the Federated Malay States for the Malayan Tin Dredging Co., Ltd.

A. F. BELDING is back from the United States.

J. W. BENNIE has taken charge of the Amster interests at Gleeson, Arizona.

C. P. C. BERESFORD, manager of Prestea Block A, left on the 14th on his return to West Africa.

JAMES P. BEST has left for Jemaa, Nigeria.

W. E. BLELOCH is here from South Africa.

GEORGE BOTTOMS is here from Nigeria.

A. R. CANNING is on his way back to Nigeria.

COURTENAY DE KALB has returned to America from Spain.

DR. CECIL H. DESCH has been appointed Professor of Metallurgy in the University of Sheffield in succession to Dr. J. Oliver Arnold, who resigned recently.

FRANCIS DRAKE has gone to Algiers.

W. R. FELDTMANN is back from West Africa.

STANLEY H. FORD is here from West Africa.

J. A. GOEPEL is leaving shortly for Nigeria.

DR. J. A. L. HENDERSON is back from Canada.

NEWTON B. KNOX is here from Spain.

GEOFFREY LEES has been demobilized from the Royal Engineers, and has resumed practice as a consulting mining engineer, with offices at 23, Fountain Street, Manchester.

D. J. MACDONALD is returning to West Africa.

J. D. MILLEN has resigned as manager of the Mount Bischoff tin mine, Tasmania.

L. A. MILLETT has gone to Eubœa, Greece, for the Anglo-Greek Magnesite Co., Ltd.

JOSIAH PAULL has been appointed consulting engineer to Grenville United Mines.

H. G. PAYNE has joined the board of Grenville United Mines.

MAJOR T. PRYOR, D.S.O., has been demobilized, and has left to resume his position at the Ooregum mine, India.

JAMES ROBERTS has returned to Jos, Nigeria.

E. R. SCHOCH has resigned as consulting engineer to the Rooiberg Minerals Development Company.

J. E. STEAD has been nominated for the presidency of the Iron & Steel Institute.

H. F. STRANGWAYS is with the Cerro de Pasco Company, Peru.

JOSEPH B. UMPLEBY has been appointed professor of geology in the University of Oklahoma.

W. F. WHITE has been away from the City for over a month owing to a severe attack of bronchitis.

ERNEST WILLIAMS has gone to Brazil.

DANIEL C. GRIFFITH, the head of the well-known London firm of assayers and metallurgists, died last month.

REUBEN E. SMITH met his death by drowning by the overturning of a boat in the rapids of the Upper Ulya River, on the west coast of the Okhotsk Sea, on August 29 last. He was born 45 years ago in California, and received his early training as a placer-mining engineer in his native State and in Colorado. At the age of thirty he went to Vladivostok and was in charge of mining operations in the Suchan coalfield. Subsequently he was engaged in gold placer operations in various parts of Siberia and Korea. For three years he was with the Lenskoie Company; some of his work there was described in the Magazine for September, 1916. At the time of his death he was exploring the Okhotsk goldfields.

TRADE PARAGRAPHS

ALLEY & MACLELLAN, LTD., of Glasgow, have issued a new air pamphlet No. 15, describing the latest designs of "Sentinel" air-compressors. This pamphlet will be sent post free on application.

HUGH WOOD & CO., LTD., of Newcastle on-Tyne, send us their new catalogue of haulage gear, winding engines, centrifugal pumps, air-compressors, hammer-drills, and the Jeffrey coal-cutter. They also send us their calendar for 1920. The coloured pictures, humorously illustrating business sayings, are gems.

JOHN & EDWIN WRIGHT, LTD., of the Universe Rope & Twine Works, Birmingham, send us a memento of the 150th anniversary of the foundation of the business. This firm had an excellent show of their wire ropes at the Royal Agricultural Society's exhibition in London last month.

MATHER & PLATT, LTD., of Manchester, have commenced the issue of a house organ called "*Ours*." The firm was founded a hundred years ago, and for a long time devoted sole attention to textile machinery. They later took up electrical work, and, acquiring the Hopkinson patents, developed one of the historical dynamos. They were early in the field with high-lift turbine pumps, based on the designs of the late Professor Osborne Reynolds.

ALLDAYS & ONIONS, LTD., Great Western Works, Birmingham, send us some information relating to tests of the Charlier type of rolling furnace working on non-ferrous metals. This information is based on figures supplied by the French metallurgist, M. Espagne. The Charlier furnace is of drum-shaped construction, lined with a suitable refractory, and mounted on trunnions. It is suitable for either oil or gas firing, and the burner is arranged to play through one of the trunnions direct into the melting chamber. No crucibles are employed, and the pour is effected by tilting. The tests give particulars of the fuel consumption and of melting losses.

METAL MARKETS

COPPER.—This market has seen a very considerable advance during the month of December, as is evidenced by the fact that at the end of November the settlement price of standard copper stood at £95. 5s., while on December 31 it had advanced to £115. 10s. After the activity which was witnessed in the summer in the American market, matters had drifted into a rather lethargic state, and in spite of much talk as to the consumption being sufficient to use up production, the fact was that stocks had apparently been accumulating further. The consequence was that the inevitable reaction took place, and prices in America declined sharply to round about 18 cents per lb. During the period under review, however, sentiment has largely changed round. It was recognized that the value to which the market had reacted was not so very much above the cost of production, and in addition there was talk in various quarters in America of output being further voluntarily curtailed. In spite of these factors it took some little time for the possibilities of the market to be recognized, which may be partly due to the fact that a tremendous amount of interest has been taken recently in certain other metals, and this may have detracted attention from copper. Another reason was that the moulders' strike in this country was keeping down the consumption of the metal here. The tone, however, gradually improved, and on the reopening of the market after the Christmas holidays, an enormous burst of activity developed.

DAILY LONDON METAL PRICES: OFFICIAL CLOSING
Copper, Lead, Zinc, and Tin per Long

	COPPER				
	Standard Cash	Standard (3 mos.)	Electrolytic Ingots	Electrolytic Wire-Bars	Best Selected
	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
Dec.					
10	101 0 0 to 101 5 0	102 10 0 to 102 15 0	110 0 0 to 112 0 0	110 0 0 to 112 0 0	109 0 0 to 111 0 0
11	101 5 0 to 101 10 0	103 0 0 to 103 5 0	111 0 0 to 115 0 0	113 0 0 to 115 0 0	109 0 0 to 111 0 0
12	102 5 0 to 102 10 0	103 17 6 to 104 0 0	113 0 0 to 116 0 0	114 0 0 to 116 0 0	113 0 0 to 115 0 0
15	103 5 0 to 103 10 0	104 15 0 to 105 0 0	114 0 0 to 117 0 0	115 0 0 to 117 0 0	113 0 0 to 115 0 0
16	103 10 0 to 103 15 0	104 15 0 to 105 0 0	114 0 0 to 117 0 0	115 0 0 to 117 0 0	114 0 0 to 115 0 0
17	104 15 0 to 105 0 0	106 5 0 to 106 10 0	115 0 0 to 118 0 0	116 0 0 to 118 0 0	114 0 0 to 115 0 0
18	103 12 6 to 103 17 6	105 2 6 to 105 7 6	115 0 0 to 118 0 0	116 0 0 to 118 0 0	114 0 0 to 115 0 0
19	104 0 0 to 104 5 0	105 10 0 to 05 15 0	115 0 0 to 118 0 0	116 0 0 to 118 0 0	114 0 0 to 115 0 0
22	104 0 0 to 104 5 0	105 10 0 to 100 15 0	115 0 0 to 118 0 0	116 0 0 to 118 0 0	114 0 0 to 115 0 0
23	104 5 0 to 104 10 0	105 15 0 to 106 0 0	115 0 0 to 118 0 0	116 0 0 to 118 0 0	114 0 0 to 115 0 0
24	106 10 0 to 106 15 0	108 5 0 to 108 10 0	115 0 0 to 118 0 0	116 0 0 to 118 0 0	114 0 0 to 115 0 0
29	111 10 0 to 111 15 0	113 10 0 to 113 15 0	118 0 0 to 121 0 0	119 0 0 to 121 0 0	114 0 0 to 115 0 0
30	116 5 0 to 117 0 0	119 5 0 to 119 10 0	125 0 0 to 128 0 0	126 0 0 to 128 0 0	124 0 0 to 125 0 0
31	115 5 0 to 115 10 0	117 15 0 to 118 0 0	125 0 0 to 128 0 0	126 0 0 to 128 0 0	124 0 0 to 125 0 0
Jan.					
2	116 0 0 to 116 5 0	118 5 0 to 118 10 0	124 0 0 to 126 0 0	124 0 0 to 126 0 0	123 0 0 to 124 0 0
5	120 0 0 to 120 5 0	122 7 6 to 122 12 6	126 0 0 to 128 0 0	126 0 0 to 128 0 0	123 0 0 to 124 0 0
6	120 0 0 to 120 5 0	123 0 0 to 123 5 0	125 0 0 to 127 0 0	125 0 0 to 127 0 0	124 0 0 to 125 0 0
7	117 0 0 to 117 5 0	119 15 0 to 120 0 0	125 0 0 to 127 0 0	125 0 0 to 127 0 0	124 0 0 to 125 0 0
8	116 10 0 to 116 15 0	119 0 0 to 119 5 0	124 0 0 to 126 0 0	124 0 0 to 126 0 0	124 0 0 to 125 0 0
9	117 10 0 to 117 15 0	120 0 0 to 120 5 0	123 0 0 to 125 0 0	123 0 0 to 125 0 0	123 0 0 to 124 0 0

Dealings in standard became very active, and prices advanced by leaps and bounds. It seems that this was to some extent stimulated by the report that the well known Vogelstein and American Metal interests in America were amalgamating. Hitherto these concerns had been an important source of supply for buyers here outside of the American Copper Export Association. The fact that the two were amalgamating, and the fear, whether justified or not, that they might possibly be joining forces with the Export Association was regarded as a bull factor of considerable importance. Standard copper, as already stated, advanced very sharply, and in doing so raised the value of refined here also. This latter point does not seem to have been altogether logical, as the price of refined metal here seems to have advanced beyond the parity of the New York market. The truth is that stocks of actual standard copper are low, and the price was relatively cheap compared with refined. Therefore some readjustment in values was quite in the natural order of things, but instead of the two values having been allowed to come together, the price of refined kept its distance from standard. The improved tone of the standard market brought in a considerable amount of consumers' orders, but at the higher level this has been somewhat stayed. Meanwhile manufactured copper has been in very good request, and makers are sold up for sheets practically till September.

Average price of cash standard copper: December 1919, £103. 17s. 2d.; November, 1919, £98. 18s. 9d.; December 1918, £116. 5s.; November 1918, £122. 5s.

TIN.—This market also has seen a very considerable advance in values during the month of December, the price of standard having risen to the extent of about £45 per ton in that period. This phenomenal movement seems to be very largely the result of speculation. It was believed in some quarters a little while ago that tin would advance to £350, which forecast has since been more than realized. This belief seems to have had the effect of bringing in a great deal of buying for the rise, which has assisted materially in bringing the advance about. It is generally considered in well informed quarters that the position of tin is quite sound intrinsically, that is to say, the consumption shows a tendency to grow, while the same cannot be said of production. At the same time the general rise in costs, in addition to the very high price of silver, seems likely to increase the cost of production of the metal, particularly in the East. These various points seem to have been generally recognized by those prominently connected with the trade, but the present position of the market is not looked upon altogether with equanimity, as obviously a very large bull account must have been built up by those who have not bought for the purpose of consumption, but merely for the sake of realizing again at a profit. Consequently the position is vulnerable and liable to sharp reactions. In the meantime the American demand has not been quite so good, although latterly this has improved considerably. Home requirements have been quite good, this being of course encouraged by the activity of the tinplate trade. The Continent has also done a little. Values in the east have been strong, but it has been noticeable that the price there, instead of leading the London market, as is often the case, has been following the trend of values here. There are further signs of China offering, while Batavia holds for high figures.

Average price of cash standard tin: December 1919, £314. 5s. 1d.; November 1919, £283. 13s. 8d.; December 1918, £267. 14s. 3d.; November 1918, £317. 7s. 7d.

LEAD.—Business in this article has been exceedingly active, so far as operations on the London Metal Exchange are concerned, where the daily turnover has been of very large dimensions. This again is largely to be attributed to the heavy speculative movement which has been little short of rampant in this metal, and as a consequence prices have, during the month, advanced something like £8 per ton. For some time past it has been recognized that the position of the metal was strong owing to the fact that the stocks in this country were steadily diminishing, and that future supplies were likely to be short owing to the fact that there was no settlement of the Broken Hill strike, so that sooner or later shipments from that quarter must come to an end. Meanwhile Spain seems to have been sufficiently occupied in supplying France, although latterly, for special reasons connected with transport, some supplies from that quarter have been coming in

PRICES ON THE LONDON METAL EXCHANGE.
Tons; Silver per Standard Ounce; Gold per Fine Ounce.

Lead: Soft Foreign	Lead: English	Zinc (Spelter)	Standard Tin: Cash	Standard Tin: 3 mos.	Silver: Cash	Silver: Forward	Gold	
£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.			s. d.	Dec.
40 7 6 to 40 10 0	41 10 0	53 5 0 to 53 15 0	306 10 0 to 306 15 0	308 0 0 to 308 5 0	[illegible]	[illegible]	108 [illegible]	10
40 10 0 to 40 12 6	41 10 0	53 7 6 to 54 7 6	306 10 0 to 306 15 0	308 0 0 to 308 5 0	76½	[illegible]	109 [illegible]	11
40 5 0 to 40 7 6	41 5 0	53 0 0 to 54 0 0	308 15 0 to 309 0 0	310 10 0 to 310 15 0	[illegible]	[illegible]	[illegible]	12
39 12 6 to 39 15 0	40 15 0	52 15 0 to 53 7 6	315 0 0 to 315 5 0	316 10 0 to 316 15 0	[illegible]	77½	111 [illegible]	15
39 7 6 to 39 10 0	40 10 0	52 0 0 to 52 15 0	313 10 0 to 313 15 0	314 15 0 to 315 0 0	79[illegible]	77[illegible]	111 [illegible]	16
39 12 6 to 39 15 0	40 10 0	51 15 0 to 52 7 6	314 15 0 to 315 0 0	316 10 0 to 316 15 0	78	[illegible]	[illegible]	[illegible]
40 2 6 to 40 5 0	41 0 0	52 10 0 to 53 5 0	318 0 0 to 318 5 0	319 10 0 to 319 15 0	[illegible]	[illegible]	107 7	18
41 10 0 to 41 10 0	42 5 0	53 5 0 to 54 0 0	322 0 0 to 322 5 0	322 15 0 to 323 0 0	79[illegible]	77	110 6	[illegible]
43 15 0 to 44 2 6	45 0 0	53 15 0 to 54 10 0	325 5 0 to 325 10 0	326 15 0 to [illegible] 0 0	[illegible]	[illegible]	[illegible]	22
44 0 0 to 44 5 0	45 0 0	54 5 0 to 55 0 0	324 5 0 to 324 10 0	[illegible] 15 0 to 326 0 0	77[illegible]	76	[illegible] 0	[illegible]
44 10 0 to 44 15 0	45 10 0	55 15 0 to 56 10 0	329 5 0 to 329 15 0	331 0 0 to 331 5 0	[illegible]	[illegible]	109 [illegible]	[illegible]
45 7 6 to 45 12 6	46 10 0	57 10 0 to 58 10 0	337 10 0 to 338 0 0	340 0 0 to 340 5 0	[illegible]	75	[illegible] 3	[illegible]
45 10 0 to 45 15 0	46 10 0	56 15 0 to 57 12 6	342 0 0 to 342 5 0	344 5 0 to 344 10 0	76½	[illegible]	109 2	[illegible]
45 7 6 to 45 15 0	46 10 0	56 17 6 to 57 15 0	341 5 0 to 341 10 0	343 5 0 to 343 10 0	[illegible]	74	109 [illegible]	31
								Jan
45 15 0 to 46 5 0	46 15 0	58 10 0 to 59 10 0	347 10 0 to 347 15 0	349 10 0 to 349 15 0	[illegible]	74	109 0	2
47 10 0 to 47 15 0	48 10 0	59 10 0 to 61 10 0	365 0 0 to 365 10 0	367 0 0 to 367 10 0	[illegible]	74[illegible]	109 [illegible]	[illegible]
47 12 6 to 48 5 0	49 0 0	59 10 0 to 61 10 0	364 0 0 to 364 10 0	367 15 0 to 368 0 0	76⅞	75[illegible]	[illegible]	6
47 17 6 to 48 7 6	49 0 0	57 10 0 to 59 10 0	356 15 0 to 357 0 0	359 0 0 to 359 10 0	[illegible]	75¾	[illegible]	7
47 15 0 to 48 5 0	49 0 0	58 0 0 to 60 0 0	359 0 0 to 359 10 0	361 0 0 to 361 10 0	78	[illegible]¼	110 0	[illegible]
47 15 0 to 48 10 0	49 0 0	59 0 0 to 61 0 0	372 0 0 to 372 10 0	374 10 0 to 374 15 0	[illegible]½	[illegible]	110 0	9

here. It is reported that considerable buying has been done by Europe from America, but it seems improbable that much relief can be expected from the United States, as the market in that country is strong. Trade in this country has been fairly good, and a good deal of business has been done with consumers. There has also been a good export movement to the Continent. These factors have been the means of stimulating a lot of purchasing on speculative account on the Metal Exchange. It is noticeable that the same parcels of lead change hands over and over again, so that when declarations were received on arrival of the metal they went round and round the market. The position would be vulnerable if any change in sentiment took place.

Average price of soft pig lead: December 1919, £41. 7s. 8d.; November 1919, £34. 16s. 1d.; December 1918, £40; November 1918, £31. 12s. 4d,

SPELTER.—In the general advance which has taken place in practically all non-ferrous metals, this article has been no exception, and during the month of December has risen in value to the extent of fully £8 per ton. Again in this case speculation has had a good deal to do with the rise, although no doubt the position in itself is sound enough. The fact of the matter is that even at the present price it is understood that production cannot be carried on profitably in this country. Supplies from Germany are virtually non-existent, and this country has therefore practically to rely upon America. In view of the various labour troubles there, coal shortage, etc., it seems to have been generally feared that a shortage of spelter might result, and a good deal of buying by dealers was indulged in on this belief. In addition to this there has been a very good demand for the metal from consumers. On the top of this came the speculative buying, and a very large business has been put through on the Metal Exchange, where again some parcels of metal seem to be changing hands repeatedly. Slight reactions have occurred when speculators were inclined to take their profits, but the market very soon revived again. The present position is such that reactions of this sort will be liable to occur again as re-sales take place, although generally speaking no material decline in values seems probable in the near future.

Average price of spelter: December 1919, £53. 9s. 3d.; November 1919, £46. 17s. 3d.; December 1918, £54; November 1918, £52. 7s. 7d.

ZINC DUST.—There has been a firm tone in this market, and the price of Australian high-grade (88 to 92% metallic zinc) has been raised to £85 per ton.

ANTIMONY.—Throughout December, the price of English regulus ruled at £47. 10s. per ton. The tone latterly became firm, however, and early in January the price advanced to £60. Foreign regulus, after having been done at £46 on spot, advanced to about £58.

ARSENIC.—This market is quiet but firm, with small supplies. The quotation for white delivered London is about £67. 10s. per ton.

BISMUTH.—12s 6d. nominal per lb.

CADMIUM.—6s. 3d. to 6s. 6d. per lb.

ALUMINIUM.—£150 per ton for home trade.

NICKEL.—£215 per ton for the home trade, and £220 per ton for export.

COBALT METAL.—10s. 6d. per lb

COBALT OXIDE.—7s. to 8s. per lb.

PLATINUM.—Considerably higher at 770s. per oz.

PALLADIUM.—Has advanced to 800s. per ounce.

QUICKSILVER.—£24. per bottle.

SELENIUM.—12s. to 15s. per lb.

TELLURIUM.—95s. to 100s per lb.

SULPHATE OF COPPER.—£43 to £44 per ton.

MANGANESE ORES. — Indian grades are quoted about 3s. per unit c.i.f. U.K.

TUNGSTEN ORES.—Wolframite 65% and scheelite 65%, 30s. to 32s. 6d. per unit.

MOLYBDENITE.—85%, 55s. per unit.

SILVER.—This market has been strong, and touched the record price of 79¼d. per oz. At this level, however, a reaction occurred, and at the end of Decmber the price stood at 76d.

GRAPHITE.—80%, £35 to £40 per ton c.i.f. U.K.

CHROME ORES.—48 to 50%, £8 per ton.

IRON & STEEL.—Business in the pig iron market has not been particularly active during the past month, but this is rather due to reluctance of sellers than to any lack of desire to buy. The moulders' strike has continued throughout the month, and at the time of writing still remains uusettled. In spite of that, foundry iron has been scarce, and even forge grades are now less abundant.

STATISTICS.

Production of Gold in the Transvaal.—Par Values.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
October, 1918	667,955	11,809	679,764	2,887,455
November	640,797	17,904	658,701	2,797,983
December	630,505	10,740	641,245	2,723,836
Year 1918	8,197,959	221,734	8,419,693	35,768,688
January, 1919	662,205	13,854	676,059	2,871,718
February	621,188	15,540	636,728	2,704,647
March	694,825	17,554	712,379	3,025,992
April	676,702	18,242	694,944	2,951,936
May	706,158	18,837	724,995	3,079,583
June	682,603	19,776	702,379	2,983,515
July	705,523	19,974	725,497	3,081,713
August	686,717	19,952	706,669	3,001,739
September	680,359	18,199	698,558	2,967,287
October	705,313	18,409	723,722	3,074,174
November 30	657,845	20,125	677,920	2,879,834

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
October 31, 1918	173,153	11,824	4,749	189,726
November 30	160,275	11,826	4,016	176,117
December 31	152,606	11,851	3,180	167,637
January 31, 1919	160,599	11,848	3,539	175,986
February 28	172,359	11,868	4,264	188,491
March 31	175,620	11,168	5,080	191,868
April 30	175,267	11,906	5,742	192,915
May 31	173,376	12,232	5,939	191,547
June 30	172,505	12,544	5,831	190,880
July 31	173,613	12,453	5,736	191,802
August 31	170,844	12,450	5,655	188,949
September 30	169,120	12,392	5,294	186,806
October 31	167,499	12,691	4,492	184,682
November 30	164,671	12,565	4,337	181,573

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 65% of the working profit. Figures based on par value of gold.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
October, 1918	2,015,144	28 0	22 5	5 3	531,774
November	1,899,925	28 5	23 1	5 1	480,102
December	1,855,991	28 7	23 0	5 6	507,860
Year 1918	24,922,763	27 11	21 7	6 0	7,678,129
January, 1919	1,942,329	28 9	23 0	5 8	547,793
February	1,816,352	28 9	23 2	5 6	498,204
March	2,082,469	28 2	22 6	5 6	573,582
April	1,993,652	28 7	22 9	5 9	573,143
May	2,099,450	28 4	22 3	5 10	608,715
June	2,032,169	28 4	22 4	5 10	592,361
July	2,134,668	27 10	21 9	6 0	611,118
August	2,036,128	28 5	22 11	5 5	551,203
September	2,019,109	28 6	22 10	5 7	560,979

Production of Gold in Rhodesia and West Africa.
Par Values.

	Rhodesia.		West Africa.	
	1918	1919	1918	1919
	£	£	£	£
January	253,807	211,917	107,863	104,063
February	232,023	220,885	112,865	112,616
March	230,023	225,808	112,605	112,543
April	239,916	213,160	117,520	109,570
May	239,205	218,057	126,290	100,827
June	225,447	214,215	120,273	106,612
July	251,740	214,919	117,581	102,467
August	257,096	207 339	120,526	103,112
September	247,885	223,719	115,152	100,401
October	136,780	204,184	61,461	91,352
November	145,460	186,462	108,796	—
December	192,870	—	112,621	—
Total	2,652,250	2,340,665	1,333,553	1,043,563

Transvaal Gold Outputs.—Par Values.

	October, 1919		November, 1919	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Aurora West	12,350	13,131	13,000	14,321
Bantjes	—	—	—	—
Barrett	—	—	—	210*
Brakpan	42,000	78,876	44,000	82,188
City & Suburban	23,648	32,582	18,496	28,331
City Deep	60,000	108,998	54,000	101,003
Cons. Langlaagte	42,400	53,405	36,500	49,572
Cons. Main Reef	46,100	73,232	44,000	69,342
Crown Mines	182,000	248,928	163,000	233,021
Durban Roodepoort Deep	21,900	29,951	20,700	28,585
East Rand P.M.	134,000	159,288	126,000	151,112
Ferreira Deep	33,400	45,447	30,400	45,646
Geduld	44,600	67,192	44,200	68,139
Geldenhuis Deep	45,400	52,617	44,100	51,977
Ginsberg	—	—	—	—
Glynn's Lydenburg	3,112	5,517	3,548	6,948
Goch	14,400	12,658	13,100	11,050
Government G.M. Areas	126,000	217,826	109,000	199,301
Heriot	11,000	15,052	10,620	14,255
Jupiter	26,300	31,398	23,200	26,700
Kleinfontein	51,000	71,823	50,000	66,998
Knights Central	23,000	30,865	21,000	28,542
Knights Deep	84,900	67,080	82,600	61,811
Langlaagte Estate	38,520	47,347	32,600	42,156
Luipaard's Vlei	18,230	750	15,810	15,120
Meyer & Charlton	14,700	41,188	13,000	37,006
Modderfontein	78,000	169,203	77,000	173,868
Modderfontein B	59,000	125,501	50,000	114,072
Modderfontein Deep	44,400	98 239	40,700	93,872
New Unified	11,500	11,950	9,600	11,107
Nourse	40,200	50,809	38,000	48,744
Primrose	17,100	17,581	15,000	15,905
Princess Estate	20,000	26,776	17,800	22,245
Randfontein Central	150,000	177,641	135,700	155,150
Robinson	43,700	42,771	41,000	40,281
Robinson Deep	57,300	81,308	50,200	74,548
Roodepoort United	23,500	24,841	20,800	20,490
Rose Deep	52,000	64,164	44,700	51,805
Simmer & Jack	51,200	57,529	47,100	52,433
Simmer Deep	50,800	53,669	45 800	46,337
Springs	39,600	77,044	36,200	71,902
Sub Nigel	9,700	26,158	8,900	23,689
Transvaal G.M. Estates	15,890	25,963	15,540	25,640
Van Ryn	32,100	32,532	31,100	31,567
Van Ryn Deep	50,700	113,278	46,500	56,553
Village Deep	48,500	69,203	44,900	60,288
Village Main Reef	18,800	23,825	17,953	22,770
West Rand Consolidated	32,000	38,639	29,000	35,100
Witwatersrand (Knights)	34,350	39,232	31,800	36,567
Witwatersrand Deep	28,400	33 045	26,400	37,214
Wolhuter	29,700	36,230	27,000	35,965

* Fine Ounces.

West African Gold Outputs.—Par Values.

	October, 1919		November, 1919	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Abbontiakoon	8,080	17,797	7,400	17,882
Abosso	7,404	12,735	7,300	12,536
Ashanti Goldfields	6,229	22,914	6,445	29,735
Offin River	—	188	—	—
Prestea Block A	15,390	23,745	14,638	23,924
Taquah	4,551	12,259	4,803	12,744
Wassau	—	—	—	—

Rhodesian Gold Outputs.—Par Values.

	October, 1919		November, 1919	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Antelope	—	—	—	—
Cam & Motor	—	—	18,496	28,331
Eldorado Banket	—	30.724	—	—
Falcon	14,753	24,978*	14,020	23,730*
Gaika	3,155	5,815	3,118	5,435
Globe & Phœnix	5,016	5,398†	4,922	5,889†
Lonely Reef	4,600	26.131	4,480	24,995
Rezende	4,700	11,053	5,100	12,168
Rhodesia, Ltd.	945	1,545	783	340
Rhodesia, G.M. & I.	—	—	1,069	2,600‡
Shamva	49,046	34,310	50.867	38,371
Transvaal & Rhodesian	1,800	4,600	1,750	4,250
Wanderer	—	—	—	—

* Gold, Silver and Copper; † Ounces Gold; ‡ Oct. and Nov.

WEST AUSTRALIAN GOLD STATISTICS.—Par Values.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
November, 1918	1,444	70,711	72,155	306,494
December	2,739	61,314	64,053	272,208
January, 1919	*	69,954	*	*
February	733	66,310	67,043	284,779
March	*nil*	66,158	66,158	281,120
April	33	63,465	63,498	269,720
May	525	68,655	69,180	293,856
June	1,050	73,546	74,596	316 862
July	680	68,028	68,708	292,852
August	835	58,117	58,952	250,410
September	†	†	†	†
October	586	64,987	65,573	278,535
November	1,171	64,823	65,994	280,323
December	831	27,334	28,165	162,575

* By direction of the Federal Government the export figures were not published. † Figures not received.

AUSTRALIAN GOLD RETURNS.—Par Values.

	VICTORIA.		QUEENSLAND.		NEW SOUTH WALES	
	1918	1919	1918	1919	1918	1919
	£	£	£	£	£	£
January	32,134	36,238	47,600	37,100	25,000	18,000
February	58,113	46,955	45,470	43,330	28,000	24,000
March	65,412	40,267	48,020	48,000	30,000	16,000
April	29,620	63,818	47,600	61,200	30,000	24,000
May	87,885	37,456	46,740	38,200	45,000	16,000
June	45,765	41,465	51,420	44,600	32,000	17,000
July	64,347	37,395	51,000	42,060	25,000	22,000
August	61,163	51,564	44,600	49,700	21,000	20,000
September	65,751	76,340	45,900	37,120	32,000	13,000
October	*	—	54,400	36,100	40,000	28,000
November	*	—	38,200	—	25,000	51,000
December	70,674	—	56,281	—	38,000	—
Total	674,655	432,196	578,213	437,410	370,000	249,000

* Figures not received.

AUSTRALASIAN GOLD OUTPUTS.—Par Values.

	October, 1919		November, 1919	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Associated	5,748	8,570	—	—
Associated Northern Blocks:				
Iron Duke	—	1,228*	—	139*
Victorious	—	363*	—	240*
Blackwater	2,349	4,646	2,121	4,376
Bullfinch	5,800	6,018	5,600	4,480
Golden Horseshoe	12,408	24,567	—	—
Great Boulder Prop.	11,545	33,524	1,129	3,617
Ivanhoe	15,357	29,831	—	—
Kalgurli	3,611	8,523	—	—
Lake View & Star	10,287	11,947	—	—
Mount Boppy	—	—	—	—
Oroya Links	1,241	8,690†	—	—
Progress	1,300	1,539	1,240	1,901
Sons of Gwalia	13,426	18,826	11,288	16,704
South Kalgurli	6,970	11,322	—	—
Talisman	—	—	—	—
Waihi	15,226	24,068§	16,265	27,422‡
Waihi Grand Junction	5,190	7,316§	5,530	8,015§

* Surplus; † Total receipts; ‡ Oz. Gold and Silver; § Gold and Silver.

MISCELLANEOUS GOLD OUTPUTS.—Par Values.

	October, 1919		November, 1919	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Barramia (Sudan)	—	—	—	—
Esperanza (Mexico)	21,721	1,527‡	16,871	1,060‡
Frontino & Bolivia (C'lbia)	—	8,917	2,810	9,851
Nechi (Colombia)	105,258*	31,304†	276,616*	53,400†
Ouro Preto (Brazil)	7,500	12,990	7,200	13,280
Pato (Colombia)	32,124*	33,914†	81,413*	25,342†
Philippine Dredges (P.I.)	—	—	—	—
Plymouth Cons. (Calif'rnia)	9,300	11,667	9,000	12,082
St. John del Rey (Brazil)	—	40,000	—	33,000
Santa Gertrudis (Mexico)	30,800	36,870‡	26,890	34,390‡
Sudan Gold Field (Sudan)	—	—	—	—

* Cubic yards. † Dollars. ‡ Profit, gold and silver.

[illegible]TION OF GOLD IN [illegible]

	1916	1917	1918	[illegible]
	£	£	£	£
January	[illegible]	[illegible]	176,030	162,270
February	183,264	180,904	173,343	[illegible]
March	186,475	189,618	177,950	[illegible]
April	192,208	185,835	176,486	[illegible]
May	193,604	184,871	[illegible]	164,080
June	[illegible]	182,426	[illegible]	162,906
July	191,404	179,660	[illegible]	163,795
August	192,784	181,005	172,105	[illegible]
September	192,330	183,630	170,368	[illegible]
October	191,502	182,924	167,740	157,750
November	192,298	182,388	157,176	168,419
December	205,164	190,852	170,630	—
Total	2,305,652	2,214,163	2,061,920	[illegible]

INDIAN GOLD OUTPUTS.

	October, 1919		November, 1919	
	Tons Treated	[illegible] Ounces	[illegible]	[illegible]
Balaghat	3,350	2,052	3,200	2,065
Champion Reef	11,212	6,725	11,842	6,860
Hutti (Nizam's)	—	750	—	[illegible]
Jibutil	—	—	—	—
Mysore	20,585	12,554	20,425	15,366
North Anantapur	800	1,076	[illegible]	[illegible]
Nundydroog	8,642	[illegible]	[illegible]	[illegible]
Ooregaum	[illegible]	7,517	[illegible]	[illegible]

BASE METAL OUTPUTS

		October [illegible]	Nov [illegible]
Arizona Copper	Short tons copper	1,450	[illegible]
British Broken Hill	Tons lead conc.	—	—
	Tons zinc conc.	—	—
	Tons carbonate ore	—	—
Broken Hill Block 10	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Burma Corp.	Tons refined lead	1,400	1,531
	Oz. refined silver	149,560	181 540
Cordoba Copper		—	—
Fremantle Trading	Long tons lead	—	—
North Broken Hill	Tons lead	—	—
	Oz. silver	—	—
Poderosa	Tons copper ore	[illegible]	[illegible]
Rhodesian Broken Hill	Tons lead	771	1,059
Tanganyika	Long tons copper	[illegible]	2,516
Tolima	Tons silver-lead conc.	55	65
Zinc Corp.	Tons zinc conc.	—	—
	Tons lead conc.	—	—

IMPORTS OF ORES, METALS, ETC., INTO UNITED KINGDOM.

		Dec. 1919	Year 1919
Iron Ore	Tons	366,956	5,202,707
Manganese Ore	Tons	10,485	[illegible]
Copper and Iron Pyrites	Tons	32,705	344,457
Copper Ore	Tons	1,163	13,587
Copper Matte and Precipitate	Tons	3,734	17,337
Copper Metal	Tons	[illegible]	115,012
Tin Concentrate	Tons	2,495	35,737
Tin Metal	Tons	1,379	22,902
Lead, Pig and Sheet	Tons	12,496	217,610
Zinc (Spelter)	Tons	6,331	[illegible]
Quicksilver	Lb.	233,174	2,841,893
Zinc Oxide	Cwt.	[illegible]	132,705
White Lead	Cwt.	24,726	140,754
Barytes	Cwt.	30 979	409,418
Phosphate	Tons	43,145	351,817
Brimstone	Cwt.	13,492	151,470
Boracic Compounds	Cwt.	51,675	[illegible]
Petroleum:			
Crude	Gallons	—	7,577,549
Lamp Oils	Gallons	10,362,255	153,371,858
Motor Spirit	Gallons	12,968,607	200,332,648
Lubricating Oils	Gallons	8,004,000	65,832,998
Gas Oil	Gallons	4,228,683	30,033,002
Fuel Oil	Gallons	24,504,747	265,405,203
Total Petroleum	Gallons	60,068,292	723,026 780

United States Metal Exports and Imports.

Exports.	July Tons.	Aug. Tons.	Imports.	July Tons.	Aug. Tons.
Copper Ingots	18,917	21,154	Antimony	645	375
Copper Tubes	149	132	Tin Con.	1,975	33
Copper Sheets	195	264	Tin	897	4,363
Copper Wire	2,468	1,430	Manganese Ore	15,585	8,240
Lead, Pig	2,367	4,086	TungstenCon	452	553
Zinc	8,842	11,037	Pyrites	63,088	30,705
Zinc Sheets	896	1,770			

Outputs of Tin Mining Companies.
In Tons of Concentrate.

	Oct. 1919 Tons	Nov. 1919 Tons	Year 1919 Tons
Nigeria:			
Abu	–	–	16
Anglo-Continental		–	117
Associated Nigerian	40	35	155
Benue	4	4	67
Berrida	–	–	1
Bisichi	27	20	188
Bongwelli	3	3	49
Dua	5	5	61
Ex-Lands	30	30	230
Filani	5	–	25
Forum River	18	13	156
Gold Coast Consolidated	2	2	31
Gurum River	10	12	103
Jantar	10	14	105
Jos	14	10	183
Kaduna	14	16	171
Kaduna Prospectors	11	7	65
Kano	12	8	134
Kassa-Ropp	–	–	84
Keffi	–	–	30
Kuru	22	18	249
Kuskie	3	2	9
Kwall	31	9	47
Lower Bisichi	4	7	71
Lucky Chance	2	1	26
Minna	6	–	36
Mongu	45	45	492
Naraguta	51	40	393
Naraguta Extended	30	27	256
New Lafon	–	–	125
Nigerian Tin	–	–	25
Ninghi	6	7	53
N.N. Bauchi	42	42	366
Offin River	6	–	50
Rayfield	45	45	573
Ropp	100	79	963
Rukuba	6	6	47
South Bukeru	6	10	54
Sybu	2	1	26
Tin Areas	8	2	67
Tin Fields	8	6	143
Toro	–	–	3
Union & Rhodesian Trust	–	–	6
Federated Malay States:			
Chenderiang	–	–	197
Gopeng	57	60	725
Idris Hydraulic	24	27	214
Ipoh	14	18	153
Kamunting	–	–	168
Kinta	42	36	408
Kledang	–	–	10
Lahat	45	44	417
Malayan Tin	47	33	561
Pahang	183	186	1,995
Rambutan	18	21	159
Sungei Besi	37	33	355
Tekka	42	42	419
Tekka-Taiping	23	23	289
Tronoh	121	112	1,340
Tronoh South	–	–	–
Cornwall:			
Cornwall Tailings	–	–	–
Dolcoath	–	–	554
East Pool	83	77	910
Geevor	–	–	186
South Crofty	50	51	527
Other Countries:			
Aramayo Francke (Bolivia)	172	148	2,079
Briseis (Tasmania)	11	3	186
Deebook (Siam)	32	32	274
Mawchi (Burma)	46	60	678
Porco (Bolivia)	23	28	260
Renong (Siam)	62	–	703
Rooiberg Minerals (Transvaal)	13	13	235
Siamese Tin (Siam)	95	96	647
Tongkah Harbour (Siam)	124	150	1,155
Zaaiplaats (Transvaal)	13	15	263

Nigerian Tin Production.

In long tons of concentrate of unspecified content.
Note These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1914	1915	1916	1917	1918	1919
	Tons	Tons	Tons	Tons	Tons	Tons
January	485	417	531	667	678	613
February	469	358	528	646	668	623
March	502	418	547	655	707	606
April	482	444	486	555	584	546
May	480	357	536	509	525	483
June	460	373	510	473	492	484
July	432	455	506	479	545	481
August	228	438	498	551	571	616
September	289	442	535	538	520	561
October	272	511	584	578	491	625
November	283	467	679	621	472	528
December	326	533	654	655	518	—
Total	4,708	5,213	6,594	6,927	6,771	6,166

Total Sales of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
July 1	$170\frac{1}{2}$	£34,035	£199 12 5
July 15	164	£34,595	£210 19 0
July 29	$146\frac{1}{4}$	£33,816	£231 4 6
August 12	144	£33,116	£229 19 6
August 26	142	£31,211	£219 16 0
September 9	$142\frac{1}{2}$	£28,793	£202 1 2
September 24	$145\frac{3}{4}$	£29,639	£203 7 2
October 7	$136\frac{1}{2}$	£27,037	£197 14 3
October 21	150	£29,672	£197 16 4
November 4	$141\frac{1}{4}$	£27,636	£195 13 1
November 18	150	£27,592	£183 19 9
December 2	$166\frac{3}{4}$	£25,170	£150 19 0
December 16	$175\frac{1}{2}$	£26,032	£148 6 7
December 30	152	£19,539	£128 11 1
Total and Average, 1918	4,094	£786,541	£192 0 0
January 13, 1919	160	£20,838	£130 11 0
January 27	$135\frac{1}{2}$	£17,000	£125 10 7
February 10	153	£17,441	£113 19 10
February 24	142	£15,015	£105 14 10
March 10	$144\frac{1}{2}$	£18,123	£125 8 5
March 24	$148\frac{1}{2}$	£17 877	£120 7 8
April 7	$134\frac{1}{2}$	£15,258	£111 8 10
April 22	$134\frac{1}{4}$	£15,023	£111 18 1
May 5	129	£14,919	£115 13 2
May 19	$126\frac{1}{2}$	£15,844	£125 5 0
June 2	140	£17,185	£122 15 0
June 16	139	£17,206	£123 15 9
June 30	136	£16,782	£123 8 0
July 14	145	£18,250	£125 17 3
July 28	122	£16,939	£138 16 11
August 11	$127\frac{1}{2}$	£17,125	£134 6 5
August 25	$130\frac{1}{2}$	£18,297	£140 4 3
September 8	$115\frac{1}{2}$	£16,588	£143 12 6
September 22	$135\frac{1}{2}$	£19,557	£144 6 9
October 8	72	£10,867	£150 18 7
October 20	32	£5,093	£159 3 2
November 3	$34\frac{1}{2}$	£5,235	£151 15 0
November 17	39	£6,161	£157 19 9
December 1	38	£5,905	£155 8 3
December 15	29	£5,133	£176 10 0
December 31	$14\frac{3}{4}$	£2,884	£195 10 10

Details of Redruth Tin Ticketings.

	December 15		December 31	
	Tons Sold	Realized per ton	Tons Sold	Realized per ton
		£ s. d.		£ s. d.
Grenville Utd., No. 1	6	159 0 0	$3\frac{1}{2}$	183 0 0
" " No. 1a	5	168 7 6	–	—
Tincroft Mines, No. 1	5	180 12 6	5	197 10 0
" " No. 1a	6	180 17 6	5	197 10 0
Levant Mines	7	181 7 6	–	—
Birch Tor & Vitifer	–	—	$1\frac{1}{4}$	215 0 0
Total	29		$14\frac{3}{4}$	

PRODUCTION OF TIN IN FEDERATED MALAY STATES.
Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1915	1916	1917	1918	1919
	Tons	Tons	Tons	Tons	Tons
January ...	4,395	4,316	3,558	3,149	3,765
February ...	3,780	3,372	2,755	3,191	2,673
March	3,653	3,696	3,286	2,608	2,819
April	3,619	3,177	3,251	3,308	2,855
May	3,823	3,729	3,413	3,332	3,404
June	4,048	3,435	3,489	2,950	2,873
July	3,544	3,517	3,253	3,373	3,756
August	4,046	3,732	3,413	3,259	2,955
September .	3,932	3,636	3,154	3,166	3,161
October......	3,797	3,681	3,436	2,870	3,221
November .	4,059	3,635	3,300	3,131	2,972
December .	4,071	3,945	3,525	3,023	—
	46,767	43,871	39,833	37,370	34,454

STOCKS OF TIN
Reported by A. Strauss & Co. Long Tons.

	Nov. 30, 1919	Dec. 31, 1919
	Tons	Tons
Straits and Australian Spot	1,658	1,000
Ditto, Landing and in Transit	805	800
Other Standard, Spot and Landing ...	1,537	1,658
Straits, Afloat..................................	1,310	2,515
Australian, Afloat............................	298	213
Banca, in Holland............................	1,899	2,225
Ditto, Afloat	395	1,632
Billiton, Spot	—	—
Billiton, Afloat	—	267
Straits, Spot in Holland and Hamburg	—	—
Ditto, Afloat to Continent	225	77
Total Afloat for United States............	6,503	7,666
Stock in America	4,955	3,438
Total	19,585	21,491

SHIPMENTS, IMPORTS, SUPPLY, AND CONSUMPTION OF TIN.
Reported by A. Strauss & Co. Long tons.

	Nov. 1919	Dec. 1919
	Tons	Tons
Shipments from :		
Straits to U.K.	620	2 340
Straits to America	3,290	4,260
Straits to Continent.........................	225	77
Straits to Other Places	75	501
Australia to U.K.	250	450
U.K. to America	891	919
Imports of Bolivian Tin into Europe...	2,414	961
Supply :		
Straits	4,135	6,677
Australian	250	450
Billiton	—	267
Banca	—	2,972
Standard	395	880
Total...........................		11,246
Consumption :		
U K. Deliveries................................	2,122	1,686
Dutch ,, ...	656	654
American ,, ...	6,665	6,965
Straits, Banca & Billiton, Continental Ports, etc.	509	35
Total...........................		9,340

PRICES OF CHEMICALS. January 7.

		£	s	d
Alum	per ton	10	10	[illegible]
Alumina, Sulphate of	,,	16	10	0
Ammonia, Anhydrous...............	per lb.		2	0
,, 0·880 solution	per ton	33	0	0
,, Carbonate	per lb.			[illegible]
,, Chloride of, grey......	per ton	[illegible]	0	0
,, ,, ,, pure......	per cwt.	[illegible]	15	[illegible]
,, Nitrate of	per ton	60	0	[illegible]
,, Phosphate of............	,,	110	[illegible]	0
,, Sulphate of	,,	[illegible]	0	[illegible]
Antimony Sulphide	per lb.		1	3
Arsenic, White.........................	per ton	67	[illegible]	0
Barium Sulphate	,,	12	0	0
Bisulphide of Carbon	,,	56	0	0
Bleaching Powder, 35% Cl.	,,	17	0	0
Borax	,,	[illegible]	0	0
Copper, Sulphate of	,,	41	0	0
Cyanide of Sodium, 100%.........	per lb			11
Hydrofluoric Acid	,,			7
Iodine..	,,		16	0
Iron, Sulphate of......................	per ton	4	10	0
Lead, Acetate of, white	,,	[illegible]	0	0
,, Nitrate of	,,	60	0	0
,, Oxide of, Litharge	,,	[illegible]	0	0
,, White	,,	61	0	0
Lime, Acetate, brown.............. .	,,	15	0	0
,, ,, grey 80%............	,,	21	0	0
Magnesite, Calcined	,,	22	0	0
Magnesium Chloride	,,	16	0	0
,, Sulphate...............	,,	12	0	0
Methylated Spirit 64° Industrial	per gal.		5	7
Phosphoric Acid	per lb.		1	[illegible]
Potassium Bichromate	,,		1	[illegible]
,, Carbonate	per ton	105	0	0
,, Chlorate	per lb.		1	1
,, Chloride 80%	per ton	25	0	0
,, Hydrate (Caustic) 90%	,,	115	0	0
,, Nitrate.....................	,,	60	0	0
,, Permanganate	per lb		3	3
,, Prussiate, Yellow	,,		2	1
,, Sulphate, 90%	per ton	25	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	51	0	0
,, Arsenate 45 %.............	,,	45	0	0
,, Bicarbonate	,,	[illegible]	10	0
,, Bichromate	per lb.			9
,, Carbonate (Soda Ash)...	per ton	16	0	0
,, ,, (Crystals) ...	,,	5	10	0
,, Chlorate.....................	per lb.			6
,, Hydrate, 76%	per ton	24	0	0
,, Hyposulphite	,,	[illegible]	0	0
,, Nitrate, 95%...............	,,	21	0	0
,, Phosphate	,,	[illegible]	0	0
,, Prussiate.....................	per lb.		1	[illegible]
,, Silicate	per ton	12	0	0
,, Sulphate (Salt-cake)......	,,	3	10	0
,, ,, (Glauber's Salts)	,,	[illegible]	0	0
,, Sulphide.....................	,,	[illegible]	0	0
Sulphur, Roll..........................	,,	23	0	0
,, Flowers.....................	,,	23	0	0
Sulphuric Acid, Non-Arsenical... 140°T.	,,	5	0	0
,, ,, ,, 90%	,,	7	5	3
,, ,, ,, 96%	,,	9	7	6
Superphosphate of Lime, 18%...	,,	5	0	0
Tartaric Acid............................	per lb.		3	[illegible]
Zinc Chloride	per ton	23	0	0
Zinc Sulphate..........................	,,	21	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	Jan. 6 1919 £ s. d.	Jan. 7 1920 £ s. d.
RAND:		
Brakpan	3 15 0	3 13 9
Central Mining (£8)	7 11 3	11 10 0
City & Suburban (£4)	15 0	9 0
City Deep	2 13 0	3 6 3
Consolidated Gold Fields	1 14 6	1 18 9
Consolidated Langlaagte	1 0 0	1 6 3
Consolidated Main Reef	15 6	16 9
Consolidated Mines Selection (10s.)	1 7 3	1 13 0
Crown Mines (10s.)	2 2 6	3 16 3
Daggafontein	1 8 0	1 2 0
Durban Roodepoort Deep	10 0	10 0
East Rand Proprietary	5 0	11 6
Ferreira Deep	13 9	12 6
Geduld	1 17 6	2 16 3
Geldenhuis Deep	13 0	15 0
Gov't Gold Mining Areas	4 13 0	5 2 6
Heriot	1 0 0	11 6
Johannesburg Consolidated	1 4 0	1 14 6
Jupiter	5 0	7 6
Kleinfontein	14 3	14 6
Knight Central	5 6	7 0
Knights Deep	8 0	12 0
Langlaagte Estate	1 0 0	1 0 0
Meyer & Charlton	5 0 0	5 2 6
Modderfontein (10s.)	26 17 6	4 10 0*
Modderfontein B	7 17 6	9 8 9
Modder Deep (5s.)	7 15 0	2 15 0
Modder East	—	1 12 6
Nourse	16 3	17 0
Rand Mines (5s.)	3 0 0	4 0 0
Rand Selection Corporation	4 7 6	5 7 6
Randfontein Central	12 9	1 0 6
Robinson (£5)	16 0	14 6
Robinson Deep A (1s.)	1 0 0	1 3 9
Rose Deep	18 9	1 5 0
Simmer & Jack	4 9	6 6
Simmer Deep	3 0	3 3
Springs	3 13 9	3 2 6
Sub-Nigel	1 13 9	1 2 6
Union Corporation (12s. 6d.)	15 6	1 3 0
Van Ryn	17 6	1 1 3
Van Ryn Deep	3 12 6	5 3 9
Village Deep	17 6	17 6
Village Main Reef	14 6	7 6
Witwatersrand (Knight's)	1 5 0	1 1 3
Witwatersrand Deep	14 0	11 6
Wolhuter	5 0	5 9
OTHER TRANSVAAL GOLD MINES:		
Glynn's Lydenburg	1 2 6	16 3
Sheba (5s.)	1 3	2 3
Transvaal Gold Mining Estates	15 0	18 9
DIAMONDS IN SOUTH AFRICA:		
De Beers Deferred (£2 10s.)	16 5 0	32 5 0
Jagersfontein	4 5 0	6 17 6
Premier Deferred (2s. 6d.)	6 15 0	13 0 0
RHODESIA:		
Cam & Motor	8 0	11 0
Chartered British South Africa	1 3 3	1 0 6
Eldorado	7 0	5 6
Falcon	1 0 0	17 0
Gaika	17 9	17 6
Giant	8 0	8 6
Globe & Phœnix (5s.)	1 8 0	16 0
Lonely Reef	1 18 9	3 2 6
Rezende	4 13 9	4 0 0
Shamva	1 15 0	2 3 9
Willoughby's (10s.)	6 9	7 3
WEST AFRICA:		
Abbontiakoon (10s.)	5 0	5 6
Abosso	7 6	12 6
Ashanti (4s.)	1 0 0	1 4 0
Prestea Block A	4 0	5 6
Taquah	14 6	17 6
WEST AUSTRALIA:		
Associated Gold Mines	3 3	3 [illegible]
Associated Northern Blocks	4 0	3 3
Bullfinch	1 9	3 9
Golden Horse-Shoe (£5)	1 15 0	1 6 3
Great Boulder Proprietary (2s.)	11 3	9 0
Great Fingall (10s).	2 0	1 6
Ivanhoe (£5)	1 13 9	1 18 9
Kalgurli	12 0	1 0 0
Lake View & Oroya (10s.)	14 0	1 3 3
Sons of Gwalia	9 9	10 0
South Kalgurli (10s.)	6 6	5 6

GOLD, SILVER, *cont.*	Jan. 6 1919 £ s. d.	Jan. 7 1920 £ s. d.
OTHERS IN AUSTRALASIA:		
Blackwater, New Zealand	8 9	8 9
Consolidated G.F. of New Zealand	3 9	3 9
Mount Boppy, New South Wales	5 0	6 0
Progress, New Zealand	1 9	1 9
Talisman, New Zealand	12 0	8 9
Waihi, New Zealand	2 1 6	2 7 6
Waihi Grand Junction, New Z'lnd	15 0	12 6
AMERICA:		
Buena Tierra, Mexico	1 2 6	15 0
Camp Bird, Colorado	17 0	1 0 6
El Oro, Mexico	16 0	15 6
Esperanza, Mexico	8 6	15 6
Frontino & Bolivia, Colombia	9 0	12 6
Le Roi No. 2 (£5), British Columbia	12 6	11 3
Mexico Mines of El Oro, Mexico	5 18 9	7 0 0
Nechi (Pref. 10s.), Colombia	11 6	12 0
Oroville Dredging, Colombia	1 0 6	1 7 6
Plymouth Consolidated, California	1 3 6	1 3 9
St. John del Rey, Brazil	17 6	16 9
Santa Gertrudis, Mexico	14 6	1 12 6
Tomboy, Colorado	14 0	13 9
RUSSIA:		
Lena Goldfields	1 15 0	1 7 6
Orsk Priority	15 0	12 6
INDIA:		
Balaghat	5 6	6 3
Champion Reef (2s. 6d.)	5 3	[illegible] 0
Mysore (10s.)	2 7 6	1 1 [illegible]
North Anantapur	2 6	4 [illegible]
Nundydroog (10s.)	1 1 0	14 6
Ooregum (10s.)	18 0	16 9
COPPER:		
Arizona Copper (5s.), Arizona	2 3 9	2 2 6
Cape Copper (£2), Cape Province	2 15 0	2 2 6
Esperanza, Spain	8 6	5 9
Hampden Cloncurry, Queensland	1 5 0	1 1 3
Kyshtim, Russia	1 16 6	—
Mason & Barry, Portugal	2 12 6	2 5 0
Messina (5s.), Transvaal	5 0	5 0
Mount Elliott (£5), Queensland	3 10 0	4 0 0
Mount Lyell, Tasmania	1 5 0	1 6 0
Mount Morgan, Queensland	1 9 6	1 3 9
Mount Oxide, Queensland	6 6	8 0
Namaqua (£2), Cape Province	2 2 6	1 12 6
Rio Tinto (£5), Spain	64 0 0	49 10 0
Sissert, Russia	1 1 3	17 6
Spassky, Russia	2 0 0	1 5 0
Tanalyk, Russia	2 10 0	—
Tanganyika, Congo and Rhodesia	5 2 6	2 18 9
LEAD-ZINC:		
BROKEN HILL:		
Amalgamated Zinc	1 7 3	1 6 9
British Broken Hill	2 15 0	2 6 3
Broken Hill Proprietary (8s.)	3 0 3	2 12 6
Broken Hill Block 10 (£10)	1 12 6	1 5 0
Broken Hill North	3 0 6	2 17 6
Broken Hill South	3 0 6	2 16 3
Sulphide Corporation (15s.)	1 8 0	1 3 0
Zinc Corporation (10s.)	1 7 3	1 2 0
ASIA:		
Burma Corporation	4 10 0	14 0 0
Irtysh Corporation	1 17 6	—
Russian Mining	1 0 0	12 6
Russo-Asiatic	4 5 0	—
TIN:		
Aramayo Francke, Bolivia	3 3 9	4 12 6
Bisichi, Nigeria	14 0	16 3
Briseis, Tasmania	5 0	4 6
Dolcoath, Cornwall	8 3	8 6
East Pool, Cornwall	1 7 0	18 3
Ex-Lands Nigeria (2s.), Nigeria	2 9	3 3
Geevor (10s.) Cornwall	1 0 0	1 4 0
Gopeng, Malay	2 0 0	2 0 0
Ipoh Dredging, Malay	18 9	18 6
Kamunting, Malaya	1 12 6	2 6 3
Kinta, Malaya	2 6 3	2 15 0
Malayan Tin Dredging, Malay	2 5 0	2 8 [illegible]
Mongu (10s.), Nigeria	14 9	1 9 0
Naraguta, Nigeria	18 0	17 6
N. N. Bauchi, Nigeria (10s.)	7 3	9 0
Pahang Consolidated (5s.), Malay.	14 0	15 0
Rayfield, Nigeria	12 6	15 0
Renong Dredging, Siam	2 1 3	2 15 0
Ropp (4s.), Nigeria	1 1 0	1 12 0
Siamese Tin, Siam	3 10 0	3 15 0
South Crofty (5s.), Cornwall	2 0 0	19 0
Tehidy Minerals (15s. pd.) Cornw'l	—	1 6 3
Tekka, Malay	4 0 0	4 12 6
Tekka-Taiping, Malay	3 17 6	6 10 0
Tronoh, Malay	1 17 6	2 12 6

* £4 shares split into 8 of 10s. each.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

THE MOUNT OXIDE COPPER MINE, QUEENSLAND.

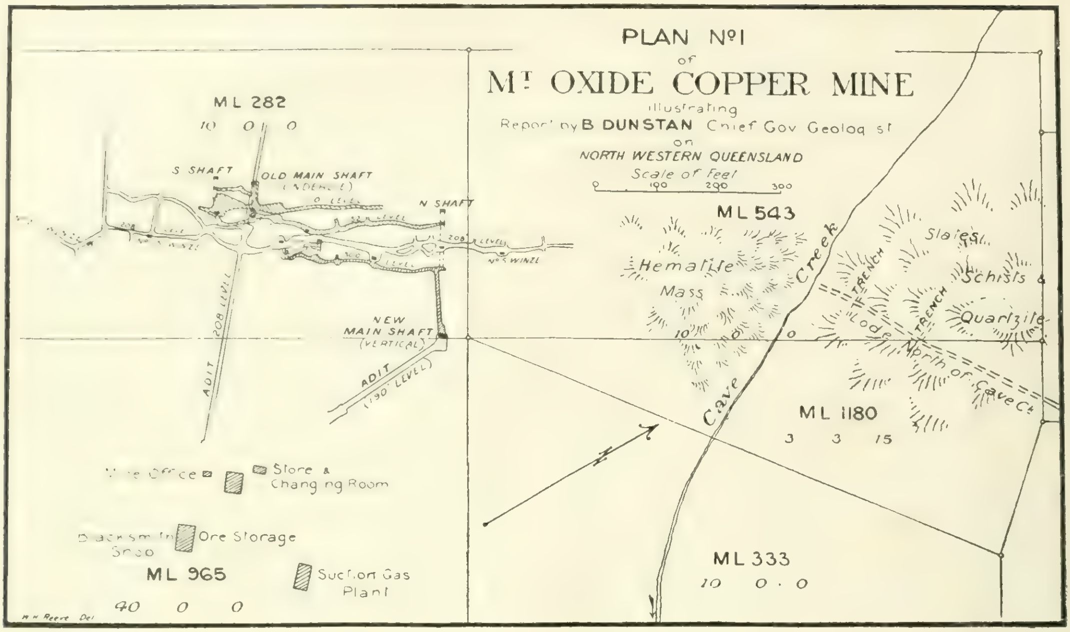
The *Queensland Government Mining Journal* for September last contains a description of the Mount Oxide copper mine, written by Mr. B. Dunstan, Chief Government Geologist.

The Mount Oxide copper mine, controlled by the Mount Elliott company, is situated in a direct line about 112 miles north-west of Cloncurry, and about 45 miles west-north-west from Kamileroi, on the Leichardt River. The nearest railway station is Dobbin, about 72 miles north from Cloncurry, from which there is a road connection to the north-north-west across Mistake and Gunpowder Creeks to Myally Creek, and then south-west along the precipitous Myally Gorge to Mount Gordon and Mount Oxide. Another route is by road from Dobbin to Lorraine Station, which is farther north than Kamileroi on the Leichardt River, and then to the western side of Myally Creek, this way being longer but not so rough as that through the gorge. The Myally Gorge is undoubtedly rough for vehicular traffic in its present condition. It could be made much better with proper road construction, as there are no very steep grades to negotiate, while the building of a railway through it would not present any engineering difficulties.

The geological formations about Mount Oxide are quartzites, slates, and schists, the quartzites forming high and rugged ridges, which alternate with the less prominent landscape features produced by the slates and schists. The alternations of quartzites and slates are very pronounced, and the trending and folding of the rock structures are sometimes observable great distances away. In the immediate neighbourhood of Mount Oxide are to be seen a number of quartzite belts, of which one in particular forms a prominence along the course of the copper lode. Alternating with this are to be seen clay slates, and a formation which might be described as a friable graphitic shale; while wedged in between the slates and the quartzite in the northern end of the portion of the lode which has been worked, is the precipitous mass of very pure red oxide of iron from which the mine has been named. The Mount Oxide lode trends south-west and north-east, and the portion more particularly examined is that between Camp Creek to the south-west and Cave Creek to the north-east. Beyond Camp Creek the lode is well-defined but no work has been carried out on it, while to the north-east of Cave Creek there is a pronounced outcrop of what might be a continuation of the Oxide lode. The configuration of the country hereabouts is rugged, however, and the behaviour of the lode cannot be ascertained until further work has been done on it. The precipitous outcrop of red oxide of iron appears to have formed where the lode has been crumpled or otherwise disturbed, and as this mass of hematite undoubtedly will have effected some change in the behaviour of the lode, developments in this direction will require careful attention later on.

The operations which have been completed show that the lode lies parallel with the strike of the rocks, with which it also conforms in its steep inclination to the south-east. The country on the south-east or hanging-wall side is mainly composed of ferruginous

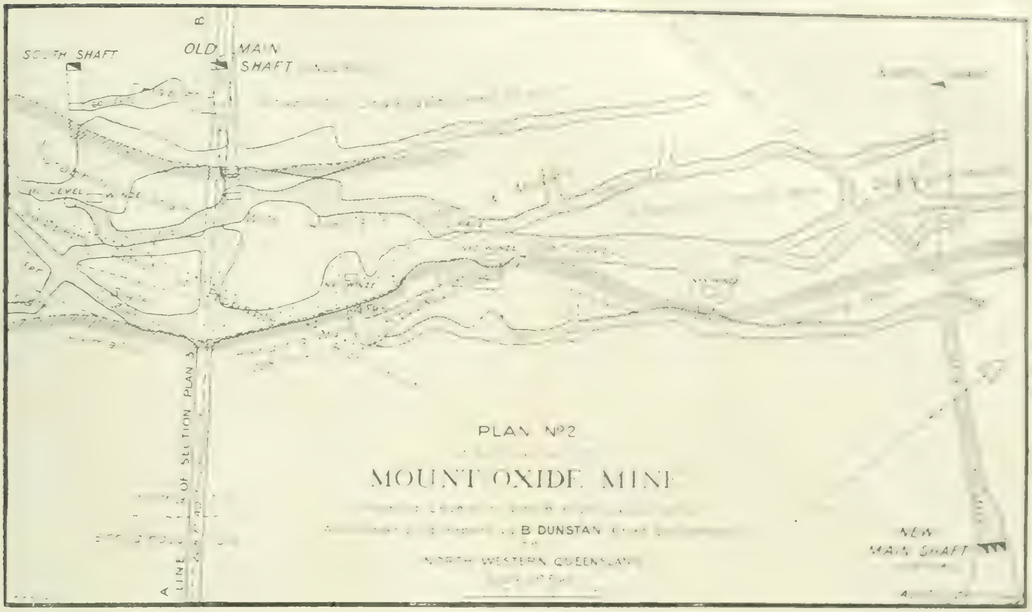
VERTICAL SECTION ACROSS THE MOUNT OXIDE LODE.



and calcareous slates and schists, on the north-west end of which, however, the hematite mass referred to sends out a long gradually narrowing tongue between the lode and the slates. On the other side of the lode —the foot-wall side— graphitic shale extends from one end to the other, so far as exposures show, but is interrupted in places by ferruginous non-graphitic slates and by irregular masses and lenses of quartzites. The slates and hematite on the hanging wall do not contain copper, but the graphitic foot-wall is impregnated with it close to the lode proper, the copper percentage gradually diminishing, however, as the distance from the lode increases, until at about 100 ft. west it is entirely absent from the graphitic rock. Farther west in the foot-wall country there are, apparently, alternations of slates and quartzites as these rocks are exposed on the western side of the lode. Longitudinally, the character of the rocks at the south end varies somewhat from those at the north, the south-end rocks containing the graphitic element alternating with veinlets and small masses of quartzite and ferruginous slate on the foot-wall side, while the hanging-wall rock is slate, more or less ferruginous and calcareous. At the north end of the foot-wall is graphitic slate and clay slate, and the hematite of the hanging wall becomes thicker as it approaches the main mass to the north-east. The lode itself, formed on the bedding plane of the sedimentary rocks, is made up of a formation of varying composition, of which the most pronounced rocks are quartzite, slate, and graphitic shale. The width of the lode is difficult to estimate, as the dimensions depend on what would be considered payable to work, some of the ore being exceedingly rich, while other portions—those on the west side—are so low in value that they can hardly be considered to be ore at all. However, the company's estimate of the width of the lode, which is 18 ft., may be taken as a fair one, as in places the width is far beyond this limit.

The mine workings consist of five levels, two adit cross-cuts, several smaller cross-cuts, a main shaft, three subordinate shafts, and a number of winzes. The main workings are the adit cross-cut at 208 ft., and the levels running north-east and south-west from it along the lode. Below this is the 300 ft. level worked from the main shaft, and above it are the 152 ft. level, the 110 ft. level, and the top level at 60 ft. There is an old main underlie shaft connected with the three top levels, the latter communicating with the adit level by means of winzes. The north shaft is an old working connected with the 152 ft. level and the adit level, and it also connects with a winze below the adit level. The accompanying plan, No. 1, gives a general idea of the underground working, while No. 2 shows more in detail the portion of the workings where the rich ore occurrences have been mapped. The total length of the adit level is about 840 ft., the length of the 300 ft. level being 250 ft., the 152 ft. level 360 ft., and the 110 ft. level 290 ft. The section on the previous page, along the adit level, is a cross-section of the workings, and shows the position of the adit level, the 300 ft. level below, and the other levels and winzes above.

The assay results indicate a rich zone or shoot of ore lying between the south shaft and the north end of the 110 ft. level. The south end of the shoot appears to dip north from the south shaft to the southern end of the 300 ft. level, while the northern end of the shoot apparently dips from the northern end of the 110 ft. level to the northern end of the 300 ft. level, the latter position being at the junction of the 300 ft. main cross-cut. The workings along the 208 ft. level within the limits given correspond with the levels above and below so far as values are concerned, and the average values in all the levels show that the ore-shoot will assay on an average 20% of copper. Regarding quantities, the rich shoot of ore contains, roughly, a block 250 ft. long, 300 ft. deep, and 10 ft. wide (where actually exposed), in which there is a reserve of over 50,000 tons of ore containing 20% of copper. The lessening values as the distance increases from the eastern wall suggests that the next 10 ft. of ore, with the same dimensions as above, also contains 50,000 tons, but with



an average content of 15% of copper. A third section of 10 ft. would yield 50,000 tons of 10% ore, and a fourth section would yield a similar amount of 5% ore, making up a total of 200,000 tons of ore having a general average of 12½% of copper.

Below the 300 ft. level no work of any kind has been undertaken, an extraordinary neglect in view of so much work being performed above this level and also about Cave Creek, which, although very useful, has no immediate practical application. The neglect might be construed into a want of confidence by the management in the deeper development of the mine, although there is nothing in the mine which should suggest the idea.

Concerning the ore in the southern workings at the 208 ft. level, it is evident that an immense deposit exists here, containing an average of 4% of copper. Cross-cuts to the south have revealed about 140 ft. as the maximum width of the ore-body, which apparently increases in width to the south but diminishes to the north. This impregnated zone, for such it appears to be, probably extends to the surface, as the outcrops show the same general characters, and, judging by its appearance and behaviour along the line, no doubt extends to greater depths.

The ore in the northern end of the same level, that is, beyond the rich shoot which seems to end at the north shaft, also shows an average of 4% of copper, and were it not for the apparent disturbance in the lode beyond the workings in this vicinity, one would feel inclined to look at this end with as much favour as the south end. As it is, 150 ft. along the lode around No. 4 winze and immediately north show a general average of 5% of copper, and the cross-cut westerly in this section of the northern end of the level averages even more than this percentage. The extreme end of the level shows very low values, and in some of the exposures there is not a trace of copper. The disturbance mentioned appears to have opened or loosened the country, and the same weathering agencies which bleached the slate at the end of the workings also leached out the copper, so that on the other side of the trouble it is probable that the copper will make its appearance again. This disturbance may be associated with the large mass of hematite referred to, and if this level is continued northerly to Cave Creek the actual conditions will then be revealed

Regarding the character and richness of the lode below the 300 ft. level, very little information is available to work upon, but the persistence of the rich shoot between the north and south shafts, and extending from the surface down to 300 ft., warrants the assumption that unless some extraordinary structural or mineralogical change takes place, of which, however, there is no indication, the richness will continue below this level and the shoot will probably be inclined toward the north. If this assumption be correct, the main shaft would intercept this shoot of ore if it were deepened a couple of hundred feet and short cross-cuts put in westerly at what would be the 400 ft. and 500 ft. levels. Otherwise, the lode might be followed below the 300 ft. level by a continuation of the No. 3 winze sunk down to this level from the 208 ft. level above.

The diminishing of the copper values as the distance westerly increases from the main ore-body seems to be associated with the occurrence of quartzite patches and lenses in the graphitic shales. The copper disappears as the quartzites disappear, and the graphitic shales to the west, where free from this silicious formation, contain no trace of the metal. Along the 208 ft. adit cross-cut these carbonaceous shales at a steep angle rest on ferruginous slates, which, again, rest on another series of quartzites. The latter are just exposed at the western end of the workings and nearly 200 ft. away from the main lode-channel.

The copper bearing outcrop on the north-east side of Cave Creek is not in line with the Mount Oxide lode, and if the latter continues on the western side of the hematite mass, as suggested, it will reach Cave Creek far above and west of the copper outcrop on the opposite side. If the two lodes are one and the same, then a severe bend or faulting of the rocks and lode in this locality will have been produced. The copper-stained outcrops are exposed in a steep side of the creek, and the trenches which have been cut at right angles with the line of lode show a section containing a great thickness of ore, and in character resembles the Mount Oxide lode formation to the south-west, but carries values probably averaging more than 5% of copper. In any later scheme for treating low-grade ore, the lode at Cave Creek would require to be brought into consideration, and future operations might reveal it as an important adjunct to the Mount Oxide mine.

Generally considered, the Mount Oxide proposition is a very sound one from whichever aspect it is looked at, either as a large body of rich ore or as a gigantic body of low-grade ore. As a rich ore mine, easy means of transit from and to it would certainly be warranted, and as a low-grade mine of course it would be impossible to do anything without the best possible railway service. Looked at from the point of view of being a valuable State asset, it would be very unwise to allow the mine to be worked simply for its high-grade contents and thereby making the rest of the large ore-body too poor for subsequent handling. Care would be necessary, however, if facilities were granted or established in the way of railway construction so that some provision be made whereby the exploitation of exclusively rich ores is prevented, and in any scheme advanced it would be advisable to make it compulsory to treat the low-grade with the high-grade ores. If such provision be made, then the great problem regarding the economical treatment of vast quantities of low-grade copper ores in the Cloncurry district will have some chance of being solved, but if the old conditions are allowed to prevail, railway facilities will only expedite the robbing of the rich parts and leave the mine in the same regrettable condition that many of the Cloncurry mines are in to-day.

ELECTRICITY AT THE MALAY TIN MINES.

At the December meeting of the Institution of Electrical Engineers, D. M. W. Hutchinson and W. J. Wayte presented a paper on the application of electricity in the working of tin mines in the Federated Malay States. We extract herewith their general recommendations.

The climate of the Malay Peninsula is moist and hot The shade temperature rarely exceeds 90°F. There are no clearly defined seasons, but spells of wet and dry weather occur at certain periods of the year. During rainy seasons thunderstorms of tropical violence are experienced daily, generally in the afternoon or evening. The rainfall varies in different districts from 90 to 130 inches for the year. Many recommendations are based on the climatic conditions.

The generator pressures recommended are : Alternating current : 440 ; 550 ; and 2,200 volts. Direct current : 115 ; 240 ; 460 ; and 550 volts. It is not advisable to generate at a higher pressure than 2,200 volts, owing to the rapid deterioration of insulating materials due to the moisture-laden atmosphere

The recommended pressures at high-tension terminals of step-up transformers are : 2,200 ; 3,300 ; 6,600 ; and 11,000 volts. So far 11,000 volts is the highest pressure in use, but there is no particular reason why higher voltages should not be used if necessary, at any rate up to 20,000 volts. For higher voltages special precautions on account of the dampness of the atmosphere would probably be necessary.

The recommended pressures on motor or consumers' terminals : Alternating current 100 ; 230 ; 400 ; and 500 volts. Direct current : 110 ; 230 ; 440 ; and 500 volts. Frequency : 50 periods. For new installations the authors recommend a voltage of 400 at motor terminals for a three-phase alternating-current system. This is the most usual voltage and its adoption would facilitate linking up and encourage local agents to keep stocks.

It is a common sight to see motors which have been rated on the assumption that they would be used in a temperate climate, working continuously up to their full load as marked on the name plate, and even at overloads ; this accounts to a great extent for the large amount of re-winding that has to be done. The temperature of the air should be taken as 95°F. under cover, and the following temperature-rises should not be exceeded : *(a)* Generators and open- and protected-type motors after 6 hours' run at full load, 63°F. *(b)* Motor driving intermittent loads, winches for instance, after one hour's run at full load, 70°F. *(c)* Enclosed and pipe-ventilated motors are seldom used and tests prescribed should be drawn up to suit each special case. *(d)* Oil-cooled transformers : maximum temperature of oil not to exceed 170°F. at continuous full load. *(e)* All standards and tests other than the above to be in accordance with British Standards as recognized by the Institution of Electrical Engineers, allowing for the higher temperature of the air. It may be considered that the temperature-rises for generators and motors are on the low side, but in a country where facilities for re-winding are doubtful and where motors are often put to work for which they were never originally intended, it is as well to be on the safe side even if it costs a little more.

The water-tube type is the most suitable boiler. These have been so far always set in brickwork, but the use of the marine type with steel casing would probably be an advantage, as neither material nor labour for brickwork is good. To keep the number of spares a minimum, a type using one length of tube only is advisable. The type of coal used as a rule, "Rawang smalls," is very suitable for firing on chain-grates. A short steel stack with induced draft is the best arrangement. It is not possible to store Rawang coal for any length of time, as it fires, so the arrangement made should aim at a steady continuous supply from truck to stoker hopper ; the experiment of storage under water will probably be tried in the near future, but it is doubtful if this class of coal is suitable.

Steam turbines are being used for plants of 500 kw. and over. There are no special considerations except that larger condensers will be required than in England as the temperature of the cooling water will be about 86°F. to 90°F., if water is returned from a cooling pond.

With regard to alternators, subject to reduced temperature-rises British Standard practice gives every satisfaction. For high pressures the most suitable switch-gear is the totally enclosed ironclad sliding-carriage type. It must be insect and lizard proof, all ventilating holes should be covered with fine gauge wire netting, and all instruments should be enclosed. For low and medium pressures the ordinary marble-panel central-station type is quite satisfactory. Here, again, precautions must be taken to prevent the entry of various small insects, especially into instruments. Where step-up transformers are used the isolating switches, and oil switches if used, on the high-tension side may be placed in cubicles near the transformer in order to shorten the length of the bare wiring, the oil switches being worked by levers from the main switchboard.

As regards cables and connections in the power house, for high pressures multicore paper-insulated lead-sheathed armoured cable should be used, and must be properly sealed and divided at the terminals. The dividing boxes at the switchboard end should be incorporated in the switch panel. For low and medium pressures rubber-insulated cables may be used.

In transformers, if there are not earth shields between primary and secondary windings provision should be made for earthing the neutral of the low-tension winding. In view of the difficulty of drying out transformer windings after they have been immersed in oil, it is recommended that moderate sizes should be shipped in oil from the factory. Air-cooled transformers are not desirable.

In transmission lines, the range of temperature experienced varies between 60°F. and 130° F., and as there is no ice or snow to contend with, a lower factor of safety can be used than that specified by the Board of Trade, but it is not usually necessary. The height of lines must not be less than 22 ft., so that steel poles are advisable, wooden poles of the necessary length being expensive and hard to obtain. Where cast-iron bases are used, the steel tube should pass through this to the bottom of the cast-iron base, and the cast iron should not be relied on to take the strain. With steel poles an earth wire is essential.

At certain periods of the year thunderstorms are of frequent occurrence, and lighting is very severe in some localities. Various types of arresters are used, but the authors are of opinion that protection for overhead lines can best be obtained by: (1) The use of step-up and step-down transformers for all but very short lines and by heavily reinforcing the insulation of the transformer coils nearest to the line, in conjunction with arresters of the horn type with carbon resistance in series with the earthed horn, or with electrolytic arresters. (2) An earth wire above the power wires earthed at frequent intervals. (3) Earthing the neutral point of the generator and step-down transformer on the low-tension side. It is a striking fact that in no case within the authors' knowledge where step-up and step-down oil-cooled transformers have been used has damage by lightning been experienced other than to the line; on the other hand, in those plants where air-cooled transformers have been used or the generators have been connected direct to the line, failures of transformers, switchboard instruments, and generators have invariably occurred even where earth wires have been used.

A voltage of 230 must not be exceeded in the lighting circuits, and this may best be obtained from a small transformer, single or three phase; if single phase the centre point of the winding should be earthed, if three phase the neutral point. The voltage between any two wires should not exceed 230. There have been several fatalities due to shock on alternating-current lighting circuits where the potential to earth was 230 or over.

Mine distribution is effected invariably by overhead wires on hard wood pole lines, the minimum height being normally 18 ft. The motors are usually placed in temporary sheds, and connections between lines and switchgear are made by rubber cables, bare wires not being allowed within 7 ft. of any building. Rubber insulation lasts about 18 months if exposed to the weather, but so far no satisfactory substitute has been found to replace it; probably three-core rubber-insulated armoured cable would last longer, as the rubber would be shielded from the direct rays of the sun. Where high-pressure leads enter a temporary building a three-core paper-insulated lead-sheathed armoured cable with proper terminal boxes and bonding appliances is called for.

The only type of mine switchgear that can be called safe is the totally enclosed interlocked ironclad type. It is now so moderate in price that there is no excuse for the employment of any other. In the past, makers have supplied entirely unsuitable switchgear, chiefly bare knife switches and bare fuses mounted on heavy marble panels. This apparatus was often to be found unfenced over a wet floor and under the charge of a bare-footed coolie. No-voltage and overload releases should be fitted in all cases. All iron work and motor frames must be earthed, and usually this means an earth plate to every motor.

In the mines, motors wound for voltages above 500 are not necessary for the majority of mining work and, except in large sizes, are undesirable. Former-wound stator coils should be used in preference to hand winding. With semi-closed slots it has been found that coils of the "cut and push through" type are the most satisfactory. The slot insulation of all former-wound coils should be of mica moulded on to the coil after winding, the coil being treated under vacuum with suitable impregnating solution before being placed in position in the slot. Trouble with hand-wound coils has been frequently experienced, more especially in high-voltage motors, due to the difficulty of packing the wires tightly inside the slot and excluding air. Manufacturers also frequently wind the coil so that the end turns are adjacent and have to withstand the full voltage of the coil. Where speed regulation is specified, brushes and slip rings should be of liberal design, and the latter should be well spaced to prevent short-circuits in starting. The most satisfactory type of resistance is the cast-iron grid, trouble having been experienced with liquid resistances. The connections between switch-panel and starter and between rotor and resistances are best made by three-core armoured cable equipped with sealing boxes, but single-core rubber-insulated cable if properly protected is quite satisfactory for medium pressures.

The usual duty required of a winch is to haul loads of three or more trucks containing about ⅔ yard of karang up an incline, which varies in length and grade, at the rate of about 12 trips an hour, the ascending trucks being partly balanced by the descending empties. The conditions vary in different mines and must be specified in each case. The winch should be of the double-drum variety with motor, resistances, switches and tramway type controller mounted on a bedplate of structural steel, the whole arrangement being as portable as is consistent with strength. The best arrangement is to mount driving spur wheel and band brake between the drums; this, without unduly increasing the width of the winch, gives the drums a wider pitch. The pitch of the rails is usually from 4 ft. 6 in. to 6 ft. 6 in., and a drum pitch of 3 ft. 9 in. gives good results. If the pitch is too narrow the turns on the drum ride over one another, and cause undue wear to the ropes besides danger of sudden jerks to the rope. One of the drums should be capable of rotation about the shaft when necessary for adjustment of the ropes, and this is usually effected by means of a clutch. One band brake held off by the driver's foot is sufficient in most cases. Electric braking has not been a great success and is generally unnecessary.

A puddler drive presents a fluctuating load. In the case of a single high-speed puddler the normal power absorbed is about 12 b.h.p., which rises to 24 whenever a load of karang is dumped, and continues at that point for about one minute. As a high-speed puddler runs at 120 r.p.m. it is usual to employ a single-reduction back-geared motor in conjunction with a belt drive, a flywheel being generally used to help the motor at the moment the karang is dumped. Gears should run in an oil bath, otherwise owing to the dust and grit which is always about they become intolerably noisy. Low-speed puddlers run at about 5 to 9 r.p.m. and the power absorbed is about 8 to 13 b h.p. per puddler. They are generally run in groups of two, and being larger and having a great inertia the fluctuations of current are not so great.

A whole treatise might be written on the subject of the use and abuse of pumps in mining. The centrifugal pump is invariably used, and wisely so, as the water pumped contains certain quantities of grit in all cases. Unfortunately it is almost impossible to place a pump and continue to work it for any length of time where it can show its best performance; sooner or later it will be put to work at an unsuitable head. The number of units wasted by the use of centrifugal pumps under unsuitable conditions must be enormous Purchasers of pumps should obtain characteristic curves for each pump they purchase; these will be supplied gladly by first-class makers. With these curves the effect of variations of speed, head, and quantity can be forecasted, and the pump run under the most favourable conditions. Without this information, however, one can only guess. Where speed variation is necessary with three-phase motors, this, if moderate, may be obtained by the use of rotor resistances; but if a larger variation is required a belt drive is generally adopted.

The cable for connecting a dredge to the shore calls for special features; it must be flexible, mechanically strong, impregnable to moisture and continual change of conditions, since it is alternately immersed in water and exposed to the sun. It should also be as light as possible. The cable used on the Tin Bentong dredge has been found satisfactory over a period of two years This is a three-core cable. The cores are insulated with vulcanized indiarubber laid together and wrapped overall with five laps of varnished cambric; the cable is then served with compounded jute and armoured with galvanized iron wire. The weight of the cable is taken by barrels floating in the dredge paddock. The armouring of the cable, however, shows signs of corrosion, and the authors therefore recommend that armouring should be heavily galvanized and covered with a protective compounded braiding. The cables for connecting the motors to the low-tension switchboard should comply with the following specification: The cables to be three-core, each core with one wrapping of paper covered with four tapes of varnished cambric, the cores being laid together and served with compounded jute, covered with a layer of varnished cambric and braided overall. The motor cables should be run in piping clamped to the framing of the dredge.

All dredge motors should be designed for a working voltage of 400. The bucket-line motor has the most exacting duty of any to perform, since it is liable to sudden shocks and overloads caused by the buckets coming into contact with limestone pinnacles, clay banks, or submerged timber. It must be reversible and capable of running slowly at light loads to permit of inspection and repairs to buckets. The speed regulator can be of the grid or liquid type; the former will probably be found more suitable in practice, as clean water is not always obtainable from the dredge pond. The remaining motors of the dredge equipment call for no special features; they must all be of the protected type, drip-proof, and capable of carrying their rated full load with a rise in temperature not exceeding 63°F. with continuous operation. The horse-power of the motors required varies considerably according to the nature of ground treated, size of buckets, and digging depth.

The total consumption of power per cubic yard treated for a moderate-sized dredge would be approximately 1·7 kilowatt-hours. The authors are of opinion that for a group of electrically-driven dredges there would be a saving of £100 per dredge per month over a steam-driven dredge.

Microscopical Studies of Cassiterite.—At a meeting of the Royal Geological Society of Cornwall, held in Penzance in November, E. H. Davison, lecturer on geology at the Camborne Mining School, read a paper entitled: "On the Mode of Occurrence of Cassiterite in some Cornish Rocks and Veinstones."

In the course of the examination of a large number of Cornish rocks and veinstones under the microscope, the author has met with some varieties and associations of cassiterite which seem to throw fresh light on its origin and occurrence. The following specimens were examined: (1) a veinstone from South Crofty; (2) a veinstone from Magdalene mine; (3) altered clay-slate from the Castle-an-Dinas district, St. Columb; (4) quartz-porphyry (elvan) from Tuckingmill.

(1). This veinstone came from South Lode, New Cook's section, South Crofty Mine, at the 125 fm. level. It is essentially composed of quartz and chlorite with a little tourmaline and fluor-spar, and some fairly well crystallized cassiterite and pyrite. The quartz is of three ages; the oldest, which is much crushed and granulated, was followed by later idiomorphic quartz crystals of fairly large size, the average diameter being about 240μ. These idiomorphic crystals have been enlarged by a growth of secondary quartz in optical continuity with the original crystal, and under low powers they are seen to be zoned, along line of growth, with pale brown and grey bands. The fluor-spar occurs with the same relations as these quartz crystals and seems to have been deposited at the same time. The higher powers resolve these zones into lines of brown and grey grains, with a few much larger brown grains scattered irregularly among them. Both large and small brown grains give the microscopic reactions of cassiterite and become coated with metallic tin on treatment with cleaned zinc dust and hydrochloric acid. On measuring these grains under the microscope the larger ones have diameters of from 5μ to 15μ, while the smaller grains composing the zone lines average about three to one division, which gives them a diameter of from 0·25 to 1μ, or 25/100,000 to 1/1000 of a millimetre. The rock section shows two crystal sections showing this zoning to perfection, one being almost at right angles to the long axis of the quartz crystal, while the other is approximately parallel to the long axis; the latter shows the pyramid end of the crystal, and in it the zonal lines are much less regular than in the cross section. In addition to these two perfect sections, many other oblique and partial sections of similarly zoned quartz crystals are to be seen in the rock section. Similar quartz crystal sections, zoned, with extremely fine-grained cassiterite have been observed in veinstones from other levels on the South Lode and from other mines, the list given below giving their number and positions.

No.	Mine	Lode	Depth from surface in fathoms
1	New Cook's South Crofty	South Lode	155
2	do	do.	160
3	East Pool	Rogers Lode	200
4	Tresavean	Main Lode	400
5	Gawton Mine	Main Lode	(surface)

In all cases the veinstone contained fluor-spar deposited at the same time as the quartz. It is seen from these sections that an appreciable proportion of the cassiterite in a veinstone may occur in grains of such fine size as to reduce materially the proportion recoverable by mechanical dressing in the mill, as the quartz crystals containing them would not be sufficiently crushed to free the grains, and the weight of the grains in the quartz fragments would be insufficient to carry the fragments with the heavier minerals on the tables. On the other hand, should any proportion of the grains be set free, they would be too fine to be caught on the tables*, as grains of 1μ diameter would pass through a standard 200 mesh sieve 60 abreast, and still have elbow room. The tin grains were obviously deposited in the veinstone simultaneously with the quartz in which they lie, which is in all cases associated with fluor-spar, and seem to have been brought there by fluorine-bearing vapours or solutions.

(2). The Magdalene mine from which these sections come is worked as an open quarry in the clay-slate and greenstone at Poonsanooth, within a few hundred yards of the granite margin. The greenstone and slate have been folded together previous to the granite intrusion, and the granite itself shows evidence of crystal movement since its consolidation. Two micro-sections of veinstone were examined; the first is seen to consist of hornblende, chlorite, and a little quartz, with magnetite and cassiterite, forming a roughly foliated veinstone, layers composed of magnetite and cassiterite being separated by bands composed of hornblende and chlorite. The cassiterite crystals are very coarse (40μ to 270μ), pale brown in colour, and frequently include the magnetite. In the second section the chief mineral components are quartz and chlorite with actinolite, hornblende, and biotite, the metallic minerals being cassiterite with a little magnetite. The cassiterite is of large size (average 200μ), and well crystallized, some crystals being beautifully zoned. The veinstones were collected from near the slate-greenstone contact. Cassiterite occurs in the slate, but in the greenstone it is sparsely distributed and of fine grain (average 20μ). There is evidence here and there in the sections that the magnetite occasionally includes the cassiterite, but the reverse is undoubtedly the general rule. The occurrence of magnetite as an associate of cassiterite is unusual, and is probably due to the presence of greenstone. An unusual character of the magnetite is that many of the crystals appear hollow under the microscope, having a roughly circular or polygonal hole in the centre filled with chlorite or actinolite and grains of magnetite, the latter being often arranged symmetrically. This seems to show that the magnetite formed as the result of the decomposition of some previously existing mineral, probably a ferro-magnesian with high iron content. The cassiterite either followed this or was deposited simultaneously.

(3) and (4) illustrate the occurrence of cassiterite in the country round mineral deposits, which seems to be more widespread than has hitherto been supposed.

A specimen of tourmalinized clay-slate (3) collected from within three feet of the wolfram lode at Castle-an-Dinas, St. Columb, shows clay-slate which has its argillaceous laminæ largely replaced by tourmaline and mica, the silicious laminæ containing less tourmaline and other alteration minerals. This tourmalinized slate is traversed by granite veins composed of quartz, tourmaline, and pale brown mica, which cut across the laminæ of the clay-slate.† These quartz veins contain badly crystallized cassiterite of medium grain (20μ to 70μ), and similar grains of cassiterite are to be seen in each of the five sections cut from different positions of the specimen. Cassiterite, therefore, seems to be spread through the country rock in the neighbourhood of a quartz-wolfram lode remarkably free from this mineral; which is shown by the fact that the wolfram concentrate at the mine contains only a negligible amount of tin. It appears that the tin was brought into the country rock of the lode at the time of tourmalinization, the wolfram lode being probably filled subsequently.

(4). It is well known that quartz-porphyries ("elvans") are occasionally tin-bearing rocks, as, for example, the elvan at Parbola and at Rosewarne mine, but examination of numerous micro-sections of such rocks indicates that it is widely spread in them in small, but not economic, proportions. The quartz-porphyry from the quarry below South Crofty mill at Tuckingmill is seen under the microscope to be an altered rock, the mica phenocrysts having been almost completely converted into chlorite, which is also common in the ground-mass. Both in these chlorite patches and in the ground-mass occur groups of cassiterite grains, poorly crystallized, and of dark colour. They vary in diameter from 5μ to 45μ and are sparsely distributed through the rock. A crushed sample of the elvan was found to contain 0·03% of cassiterite, or 0·6 lb. to the short ton, the separation being effected by the use of heavy liquids and the magnet. These cassiterite grains are associated with fluor-spar in this sample, the two minerals being invariably found together. Similar cassiterite granules have been observed in several other elvan specimens, as indicated in the following list: granite porphyry from Bolenowe Moor, Troon; fine gained granite, Carn Marth; fine-grained granite, Knill's Monument; luxulyanite, Luxulyan; granite, Botallack; pegmatite, Dolcoath; greenstone, St. Just; greisen, Castle-an-Dinas. The cassiterite in these rocks varies from dark-coloured grains of 5μ up to crystals of 45μ diameter. They occur in the ground-mass of the elvans or as inclusions in quartz or chlorite, replacing original minerals. In one case the rock shows fluor-spar structure, and the cassiterite grains occur in patches of glass.

Supporting Hanging Wall in Far East Rand. At the October meeting of the Chemical, Metallurgical, & Mining Society of South Africa, L. W. Macer read a paper on the support of the hanging wall in mines in the Far East Rand. An opinion has been widely held that the panacea for hanging-wall trouble in flat mines lay in the adoption of colliery practice, but to the author, and to others who have come to the Far East Rand with coal-mining experience, it has become apparent that to deal with a colliery roof is an entirely different proposition from the support of a Far East hanging wall. The forces acting and their directions are precisely similar in both cases, yet the effects are very different. The hanging in a longwall working subsides in a gradual manner, its surface approximating a curve from the coal face to the goaf, whereas in a flat mine on the Rand cracks develop at and parallel to the face, and the hanging throughout the stope breaks up and has none of its original stability. The result is the development of a danger zone between the last pack and the face, which means that work has to be carried on in a veritable death trap, while in coal mining perhaps the safest place in the mine is at a systematically propped longwall face.

The reasons for the difference in the conditions of hanging wall are: (1) the difference in the relative rates at which the faces of coal and reef are worked; (2) the initial resistance of the supports used in the different classes of mining.

The difference in the rate of advance of a stope face

* J. J. Beringer, *Bulletin* I.M.M. 1915.
† *Proc. R.G.S., Cornwall.* E. H. Davison, 1918.

and a longwall face is, of course, considerable. A stope face equipped with machines breaking one fathom per machine shift will only advance about 12 ft. per month, the general average for a mine being much less than this, while a longwall coal face equipped with disc coal cutters and mechanical conveyors will advance the depth of their cut, namely, 4 ft. 6 in. to 5 ft. per 24 hours. To the relatively slow advance of a stope face, the author attributes the difference in stability of roofs, although the heavy blasting and sometimes indiscreet placing of holes in stoping, no doubt, is contributory to the effect.

Coming to the second reason, it is observed that the props used in longwall systematic timbering have a considerable initial resistance, while pigstyes used in stoping have practically no initial resistance, in fact their maximum resistance is not reached until they become compressed by about 20% of their original height. This amount of compression is observed at varying, but generally considerable, distances from the face. The hanging wall is therefore supported at two points, namely, at the point in the stope where the pigstyes have reached their maximum resistance, and at the face. It therefore follows that fracture may be expected at and parallel to the face or in proximity to any pillar left in the stope. Practically, there is the phenomenon of punching.

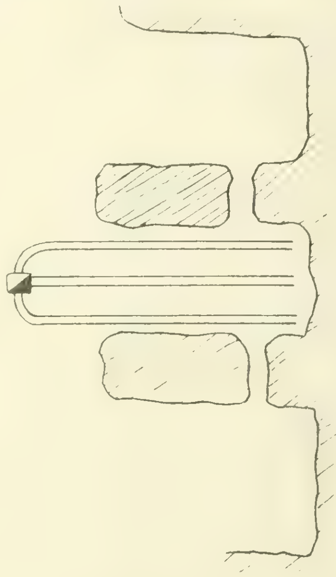
The comments expected by the author upon the above statements will no doubt be that there is no originality in them ; secondly, that stope faces cannot be speeded up ; and, thirdly, that props, notwithstanding their initial strength, are impracticable in deep level flat mines ; and, finally, that as a cure seems impossible the trouble must be endured. The author admits that the difficulties outlined have been recognized, and that steps have been taken to combat them. He proceeds to describe improvements adopted or suggested.

The increase in initial resistance of a pigstye, or cog, has been to a certain extent effected by driving wedges into the split ends of the lagging of which the pigstye is built. This method is not so effective as might be supposed, and an improved method of wedging without splitting the sticks has been introduced. A split stick (half-round) is placed flat side down in about the centre of the cog. A long wedge of small taper is driven in below the split lagging and rests in a square joggle in the next underlying stick. By driving home these long wedges the whole of the upper portion of the cog is forced up to the hanging wall.

Well built dry masonry has been used in preference to pigstyes. A pack 20 ft. square with rounded corners is used. These packs, in addition to giving a good initial resistance, resist blasting better than the pigstyes. They are built by experienced masons, and the cost appears to be rather higher than for building cogs. The masons at 20s. per day handle about three tons of stone, which does not, however, compare very favourably with a surface mason's day's work of $2\frac{1}{2}$ cu. yds.

The use of pillars in conjunction with the abovementioned supports is the generally recognized practice, notwithstanding that even the greatest advocate of the pillar admits its disadvantages. In deep-level mining it is difficult to demonstrate the utility of the pillar except under special circumstances, such as the support of faulted ground or in the process of the reduction of stoping widths. A method, comparatively recently introduced, known as the panel system, makes use of pillars regularly placed and subsequently removed. The system in conjunction with foot-wall cross-cutting is illustrated herewith. It approximates to the pillar-and-stall method in colliery work, the stalls being from 70 ft. to 120 ft. wide with pillars of 30 ft. It is undoubtedly the best method of controlling roof weight in a stope where the face advances slowly, and it effectually obviates the dangerous condition mentioned in the earlier portion of this paper.

The cog, or pigstye, has the great advantage over masonry in cost of construction, as comparatively unskilled labour can be used. It has the disadvantage of being easily damaged by blasting unless it is carefully built, and unless the stope timberman and machine man work amicably, a condition which it is difficult to obtain in practice. The author describes a design which allows of good construction by an indifferent workman and results in a pigsty which it would be difficult to blast out. Four posts are set in such a manner that the ends of the horizontal sticks do not project beyond them. Old wire rope is then passed round the posts diagonally. These ropes are drawn as taut as possible, and finally tightened by means of twisting by the insertion of a piece of pipe or jumper at the middle point. The frame is then filled with stone. Wire rope can be used in place of the horizontal sticks, and old pipe filled with concrete can be used for the posts. A plug of wood is used in the upper ends of these posts and answers two purposes. It allows of a certain amount of compression, and can be easily sawn to adapt the length of the post to the height of the stope.



The Panel System.

It may be mentioned that the question of the support of roof in the Far East Rand mines would be much more acute if it were not for the fact that, owing to unpayability, almost half the area remains unmined. As more mines become worked, however, the roof must become more troublesome, and the lay-out of underground workings and methods of mining which have been more or less satisfactory in the past will in all probability be found wanting in the future.

Extraction of Tungstic Acid.—Patent 18,206 of 1918 (134,891) describes Dr. O. J. Stannard's process for extraction of tungstic acid from wolfram ores. This process was mentioned in the report of the Tin and Tungsten Research Board quoted in the issue of July last. We give the inventor's description in full.

The object of this invention is to recover tungstic acid (WO_3) from ores, residues, or other material containing this compound in combination with iron, manganese, or calcium or with oxides of same, such for example as wolframite, hubnerite, ferberite, and scheelite. Riche *(Annales de Chimie et de Physique*, 1857, page 21) has shown that by heating tungstic acid with carbon and subjecting the reduced mixture to the action of dry chlorine gas at a moderate heat, the compounds WO_2Cl_2 and $WOCl_4$ are obtained. Smith and Fleck *(American Chemical Society's Journal*, No. 21, 1899, page 1007*)* have shown that by heating sulphur chloride (S_2Cl_2) with tungstic acid and ores containing this latter compound in sealed tubes to 145°C. oxychlorides of tungsten are produced. It has heretofore been proposed to heat to redness commercial tungsten tri-oxide in a current of carbon tetrachloride, the chlorine compounds so obtained being treated with distilled water and aqua regia to convert them into tungstic acid. It has been proposed for the purpose of extracting tin, tungsten, antimony, arsenic, and other products from the refuse slags or debris of tin-smelting furnaces to mix the ground or broken slags and debris with a chloride or chlorides, subsequently heating the mixture in a retort or furnace and collecting the resulting volatile chlorides of tin, tungsten, antimony, and arsenic or any one or more of them that may be present. The present invention is based upon the known reactions resulting in the production of chlorides and oxy-chlorides of tungsten, such as WCl_6, WO_2Cl_2, and $WOCl_4$ and other intermediate compounds of tungsten and chlorine. The crushed ore is subjected to a treatment which results in the formation of chlorides or oxy-chlorides of tungsten which are subsequently converted by suitable means wholly or in part into tungstic acid. The invention also consists in a cyclic process of the above character, in which the chlorine employed is recovered for further use. The invention also consists in the separation of stannic chloride from wolfram ores by a process of the above character.

In carrying the invention into effect, crushed ore is mixed with charcoal or any other suitable carbonaceous material, the mixture is heated to a temperature in the neighbourhood of 300°C. and subjected to the action of a current of dry chlorine gas free or nearly free from air, so that by this means all or nearly all the tungstic acid contained in the ore is decomposed and volatilized or sublimed as chlorides and/or oxy-chlorides of tungsten. The iron contained in the ore will likewise be volatilized as ferric chloride. The conversion of the chlorides and oxy-chlorides of tungsten into tungstic acid is effected by the introduction of these chlorides into hot or boiling water. A small percentage of strong nitric and hydrochloric acid may be added, resulting in the formation of a dense precipitate of WO_3 which is allowed to settle. Decantation of the superimposed acid water and repeated washing with hot acid water and settling will yield a high-grade WO_3 which is collected and dried.

The mixture of ores containing WO_3 may also be mixed with carbon to a red heat and this reduced mass treated with chlorine gas at a temperature of about 300°C., when the chlorides and oxy-chlorides of tungsten and chloride of iron are likewise obtained. Wolframite or the like contains iron in combination with WO_3 and may also contain iron in combination with accessory minerals, and such iron is also attacked by the chlorine gas, and ferric chloride thus formed distils or sublimes with the chlorides and oxy-chlorides of tungsten according to the temperature employed.

For the purpose of recovering the chlorine contained in the mixture of tungstic chlorides and oxy-chlorides, and chloride of iron, the mixture of these chlorides may be heated to the requisite temperature in a current of dry air, with the result that the iron chloride is converted into oxide or oxy-chloride of iron, while the chlorides and oxy chlorides of tungsten yield tungstic acid or oxy-chlorides of tungsten, which can be further treated. The chlorine so recovered may be employed again for the treatment of further quantities of wolframite or the like, and thus the process may be made a cyclic one. In the case of the recovery of chlorine by this method, the chloride of iron will be converted into oxide and the oxy-chloride of tungsten will be converted completely or nearly completely into WO_3, with the result that tungstate of iron will be re-formed, but in poor quality ores this will be an advantage as the concentration will have been increased and the gangue will have been left behind

The process may be utilized for obtaining stannic chloride from wolfram ores, as any tin oxide contained in mixed tin-wolfram ores will, when the temperature is raised to a bright red heat, be converted into $SnCl_4$, which distils over with the sublimed chlorides and oxy-chlorides of tungsten, and will be condensed together with these compounds. On addition of hot water and a small percentage of hydrochloric acid to the mixed sublimate and distillate, dense WO_3 will be precipitated, whereas the tin remains in solution as chloride, which is removed by repeated washing and decantation with hot water containing hydrochloric acid.

Neutralizing Acid Mine Waters.—At the September meeting of the South African Institution of Engineers, F. Wartenweiler and E. H. Croghan read a paper entitled: "The Neutralization of Acid Mine Waters on the Rand and the Settlement and Treatment of the Sludge formed." The paper dealt with the waters on the main or older part of the Rand, where the pyritic content of the ore gives rise to the acidity. In the Far East Rand the water from the overlying dolomite provides the necessary reaction.

The following table serves as an illustration of the amount of water pumped and acid content on a few of the mines:

Mine.	Gallons pumped daily.	Acidity in terms of Sulphuric Acid before Neutralizing. %
Village Deep	700,000	0·01
Ferreira Deep	260,000	0·06
Durban Roodepoort Deep	500,000	0·02
Robinson	330,000	0·02

Apart from organic compounds, arising from decomposition of timber and occasional pollution by underground sewage, the following constituents are generally contained in mine water: free sulphuric acid, soluble silica, ferric sulphate, ferrous sulphate, aluminium sulphate, and sulphates of calcium, magnesium and alkalies, together with chlorides.

In the treatment of the acid mine water the following four objects may be held in view: (1) The efficient and economic neutralization of the free acid (sulphuric) and of the acid ferric sulphate, to prevent pipe and pump corrosion. (2) The settlement underground of the solids suspended in the water so as to deliver reasonably clear water to the pumps in order to avoid excessive abrasion and choking of pipe-lines. (3) The complete neutralization of free acid, precipitation of ferric and ferrous sulphate and sulphate of magnesium and settlement of the precipitated salts to render the water suitable for use in the reduction works. (4) Neutralization of the free acid accompanied by settlement or filtration, to render the water suitable for use and re-use in underground spraying and washing in accordance with Government Regulations.

The neutralizing reagents in current use on the local mines are carbonate of soda, unslaked lime, slaked lime, and pulverulent carbonate of lime. The soda used until recently has been in the form of crude soda obtained from a natural deposit in the Pretoria district, containing 60% of Na_2CO_3. Latterly the supply from this deposit has practically ceased, and the use of soda has been greatly restricted owing to the high cost of importation. Calcium carbonate, in a natural pulverulent form of carbonate of lime, is found in extensive deposits in several parts of the Transvaal, but step (1) cannot be carried out with this carbonate of lime to quite the right degree of neutralization without the use of a large excess of reagent and a contact extending over considerable time. The neutralization of the free acid and acid ferric sulphate can be best obtained with lime, preferably with hydrated air-separated lime.

Experiments were conducted on sludge from City Deep mine with the view of studying a practical method of handling, and of the subsequent recovery of the gold content in the cyanide process. No difficulty was experienced in making a good vacuum-filter cake from ¾ in. to 2½ in. in thickness. On account of the gelatinous nature of the sludge the residual moisture in the cake, however, remained as high as 43%, and was rather soft and smeary. Using a pressure filter-press, a 2 in. cake was made in 10 to 20 minutes with a thickened pulp of from 1 : 1·7 to solid 1 : 5 liquid ratio. After air-drying in the press for 20 minutes a hardened cake, easy to handle or transport, containing only 25% moisture, was obtained. This cake would seem to meet practical requirements.

Cyanide extraction tests on this sludge, 99·9% of which passed a 200 mesh screen, and which assayed 1·02 dwt., disclosed interesting information. Air-agitation cyanide treatment of the sludge taken from the sump yielded only 46% extraction, and with a prohibitive cyanide consumption. The presence of deleterious reducing organic matter and ferrous salts was indicated. Similar extraction tests made on the partly air-dried filter-press cake yielded a 90% extraction with a normal cyanide consumption. Analysis of the effluent solutions from this last test established the oxidation of the ferrous iron to the ferric state, and is due to this press aeration. The sludge in the press had also changed in colour from a blue-grey to a bright yellow. It is evident, therefore, that the handling of the sludge, which may vary in tonnage from five to twenty tons daily on one mine, should receive consideration not only in respect to underground conditions, but also in respect to subsequent disposal on the surface.

Filter-presses of standard type and of a pipe-filter type designed by Mr. O'Donovan, of the East Rand Proprietary Mines, have been installed underground on a few mines, and the press cake is hoisted with the ore. On other mines the sludge is bailed out with skips, and is dumped and run into surface dams for oxidation and possible future treatment. The pure precipitated sludge carries no gold, the gold that is in the precipitate being due to an admixture with fines from stope washings In many instances the gold content is far too low to warrant future treatment. The great dread from a reduction officer's point of view is the practice of dumping skip loads of slushy sludge into the fines bins for direct transport to the mill. The ill effect on conveyor belts, mill feeders, battery floors and foundations can readily be imagined, not to mention the dismay at the slime plant with the resulting poor settling and high cyanide consumption.

The precipitated sludge with its admixture of mine washings varies greatly in composition and physical characteristics, according to the degree of such admixture. The following determinations were carried out for further information :

	Insoluble in Acid. %
(a) Durban Roodepoort Deep sludge	32·6
(b) E R P M sludge	72·17
(c) City Deep sludge	82·30

The driest filter-press cake made with (*a*) still contained 71·6% moisture, while (*b*) contained only 45·5%. Both, however, appeared by observation to be equal in moisture content. Sludge (*a*), after settling a fortnight and the clear water decanted, still carried 86% moisture, while (*b*) settled to 50%.

The cyanide extraction test on (*a*) sludge gave assay of original 1·04 dwt. : residue 0·45 dwt. ; recovery 56·8% ; lime consumption 75 lb. per ton ; cyanide consumption 13·6 lb. per ton. Evidently it is questionable practice, to say the least, to send such material to cyanide works.

The following analysis is of a typical underground sludge at the Durban Roodepoort Deep mine, collected during a period of heavy inflow of acid water :

Grading

	%
+ 60 (mostly fibre)	3·08
+ 90	3·46
+ 200	6·54
— 200	86·92

Elutriation Test and Assays

	Weight %	Assay Dwt. per ton.	Gold per ton original Dwt.
Granular	12·28	1·43	0·175
Colloidal............	87·72	0·59	0·518
	100·00		0·693

SHORT NOTICES

Rock-Drills.—The *Engineering and Mining Journal* for October 25 contains an article by C. A. Hirschberg, giving a history of the development of the rock-drill in America.

Ferro-Concrete in Mines.—At the December meeting of the Midland Institute of Mining Engineers, T. J. Gueritte read a paper on the applications of concrete at mines.

Mine Surveying.—In the *Mining and Scientific Press* for November 22, Douglas Waterman commences a series of articles dealing with short cuts in mine surveying.

Electrolytic Iron.—At the December meeting of the Faraday Society, W. A. Macfadyen read a paper on the electrolytic deposition of iron for engineering purposes.

Cleaning Blast-Furnace Gases.—The *Iron & Coal Trades Review* for December 19 contains an article on the Halberg-Beth dry gas-cleaning plant. The makers of this plant are Fraser & Chalmers Engineering Works, Erith.

Monterrey, Mexico.—In the *Mining and Scientific Press* for November 22, R. B. Brinsmade writes on the mining and smelting operations near Monterrey, in the State of Nuevo Leon, Mexico. The Diente silver-lead mine and the smelter belong to the American Smelting & Refining Company are described.

Coke Ovens at Anyox.—The *Canadian Mining Journal* for November 26 describes the by-product coke-ovens of the Granby Consolidated at the copper-smelter at Anyox, British Columbia.

Alcohol from Coke-Oven Gases.—At the December meeting of the Cleveland Institution of Engineers, Ernest Bury and O. Ollander read a paper on the fixation as alcohol of ethylene contained in coke-oven gases.

Manitoba Mineral Deposits.—The *Canadian Mining Journal* for November 12 prints R. C. Wallace's report on the Northern Manitoba mineral belt, dealing with Flin-Flon, Schist Lake, Copper and Brunne Lakes, Herb Lake, and other districts.

Mining in the East.—In the *Mining and Scientific Press* for November 15, Gilmour E. Brown writes on mining engineering in the Orient.

Utah Ore Deposits.— In the *Engineering and Mining Journal* for October 11, B. S. Butler commences an article on the ore deposits of Utah.

Iron Ores.—*Economic Geology* for November contains a paper by W. J. Miller on the magnetic iron ores of Clinton County, New York State.

Natal Iron Industry.—The *Iron & Coal Trades Review* for December 12 contains a description of a blast-furnace plant now being erected at Newcastle, Natal. Titaniferous magnetite ores are to be treated. The leading spirit in the enterprise is J. K. Eaton, of the Dunswart Iron & Steel Works, Johannesburg

Coal in Ulster.—The *Colliery Guardian* for December 19 quotes a paper by W. B. Wright in the Scientific Proceedings of the Royal Dublin Society, describing the geology of the country north and west of Belfast with a view of ascertaining the possibilities of finding concealed coalfields.

Potash from Wood.—*Chemical and Metallurgical Engineering* for November 19 contains a paper by Ernest Bateman giving details of investigations of potash contents of North American woods.

Lead Pencils.—At the meeting of the London section of the Society of Chemical Industry, held on November 3, C. Ainsworth Mitchell read a paper on black-lead pencils and their pigments. This is an important contribution to the technology of graphite.

Prisoners of War.—The *Bulletin* of the Canadian Mining Institute for October contains an account of the German treatment of prisoners of war. It is written by Harry Miard, who was captured during the German operations against Verdun.

RECENT PATENTS PUBLISHED.

☞ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W C.2., with a note of the number and year of the patent.*

13,209 of 1918 (118,627). W. A. SCOTT, Chicago. Using a vapourized oil in flotation for the purpose of causing a froth and also for agitation.

14,939 of 1918 (134,870). R. D. HARRIS, Seven Sisters, Glamorgan. Improvements in the inventor's apparatus for use in blasting, described in patent 118,893.

17,076 of 1918 (134,884). E. E. & P. C. DUTT, Jubbulpore, India. Method of making sulphate of magnesia from magnesite and calcium sulphide.

17,079 of 1918 (134,545). E. E. and P. C. DUTT, Jubbulpore, India. Method of making potassium sulphate from potassium fluoride by reaction with silica or clay and sulphur dioxide at red heat.

17,080 of 1918 (135,246). E. E. & P. C. DUTT, Jubbulpore, India. Producing potassium chloride from potassium fluoride by treatment with silica, carbon, and hydrochloric acid ; this process is applied to that in which silicon tetrafluoride, the other resultant of the reaction, is used for attacking felspar for the production of potassium fluoride.

17,365 of 1918 (134,885). E. W. HASLUP, New York. A process of producing cyanamide by passing air through a furnace similar to a blast-furnace and charged with carbon and the oxide of an alkali or alkaline earth metal, the action being to make an atmosphere of producer gas so that the cyanamide shall not come in contact with oxygen.

17,945 of 1918 (134,886). C. MICHEL and V RASKIN, Paris. Method of forming flue-dust into briquettes.

18,330 of 1918 (134,894). E. RIDONI, Turin. Purifying graphite by removing silica, etc., by the action of hydrofluoric acid.

18,467 of 1918 (120,908). G. O. SEWARD, New York. Improvements in the inventor's method of electrically depositing magnesium from a bath formed by dissolving magnesia in molten magnesium fluoride and the fluoride of a metal electropositive to magnesium

18,554 of 1918 (134,920). INTERNATIONAL PRECIPITATION CO., Los Angeles, California. Improved method of extracting potash from the fume of cement furnaces.

18,772 of 1918 (135,943). E. V. ESPENHAHN, Port Pirie. Recovery of sulphur dioxide when occurring in small percentages in metallurgical gases, by washing with sodium thiosulphate.

18,919 of 1918 (135,277). OSMOSIS CO., LTD., and J. S. HIGHFIELD, London. In the pumping of china clay suspended in water, adding a very small percentage of caustic soda or silicate of soda to the water, which has the effect of keeping water containing 25% of clay perfectly liquid instead of only 5% as at present.

18,993 of 1918 (135,285). J. B. PIERCE, Charleston, Virginia. Method of producing barium oxide from barium carbonate in a condition suitable for the manufacture of barium peroxide.

19,008 of 1918 (135,290) R. J. and W. SUTCLIFFE and J. SHEPPARD, Horbury, Yorkshire. Improved adjustable and collapsible prop for mines.

19,266 of 1918 (135,305). C. V. JORGENSEN, Copenhagen. Treatment of pyrolusite to produce a peroxide of manganese of greater depolarizing effect when used in electric cells

19,770 of 1918 (135,322). J. F. WAKE, Darlington. A pulverizing mill consisting of a number of rings of different diameters one within the other and resting on each other at the bottom of the casing, and revolving with the casing horizontally, the material being fed between the rings

20,076 of 1918 (135,327). J. POWANDA, Ansonia, Connecticut. Improved machine for coating sheet metal with tin or other metal on one side only.

2,132 of 1919 (135,052). W. G. RUMBOLD, London. Precipitating lead or tin from chloride solution by adding concentrated ferrous chloride and bringing it into contact with clean iron scrap.

2,193 of 1919 (135,379). W. L. ROWE, J. F. SMITH, and S. HOLLAND, London. Improved detonator for blasting purposes.

2,495 of 1919 (135,702). J. P. AREND, Dommeldange, Luxemburg. A bearing alloy consisting of copper and zinc in the proportions usual in brass, with an addition of lead constituting 10 to 60% of the finished alloy.

2,496 of 1919 (135,056). J. P. AREND, Dommeldange, Luxemburg. Method of making lead mix with alloys of copper, tin, and zinc.

3,082 of 1919 (135,065). H. C. JENKINS and H J. SHINER, Sheffield. Improvements in rock-drill chucks.

4,255 of 1919 (135,713). CHEMICAL CONSTRUCTION CO., Los Angeles, California. Method of producing potassium nitrate from the fume of cement kilns.

4,563 of 1919 (135,720). CHEMICAL CONSTRUCTION Co., Los Angeles, California. Process and plant for recovering potassium compounds from fume of cement kilns.

11,312 of 1919 (135,125). A. G. SUNDBERG and T. E. THOMASSON, Helsingborg, Sweden. Refining cement copper by roasting to oxide, dissolving in acid, and electrolysing.

16,718 of 1919 (135,147). W. M. NEILSON and A. T. HARRIS, Johannesburg. A rock-drill of the hand-hammer type. Part of claims: A rock drill or pneumatic tool, comprising, in combination, a main cylinder which is permanently open to the atmosphere at both ends, a front piston operatively arranged in the front portion of said cylinder and adapted, directly or indirectly, to strike the drill or bit, a back piston operatively arranged in the rear portion of said cylinder, a rod connecting said front and back pistons, a valve or valve device located in the cylinder intermediate the pistons movable in a direction longitudinal of the cylinder and operating in the one position to admit the pressure fluid to the back of the front piston and to place the front of the back piston open to exhaust, and in the other position to admit the pressure fluid to the front of the back piston and to place the back of the front piston open to exhaust; the valve or valve device consisting of a stationary outer member, which is located in the cylinder intermediate the pistons and a movable inner member, through which the rod connecting the pistons works, said inner member being movable in a direction longitudinally of the cylinder, the member of the valve device being constructed with co-operating ports or passages which serve in the one position of the movable member to admit the pressure fluid to the back of the front piston and to place the front of the back piston open to exhaust, and in the other position, to admit the pressure fluid to the front of the back piston and to place the back of the front piston open to exhaust.

NEW BOOKS

☛ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 723, Salisbury House, London Wall, E.C.2.

Memoirs of the Geological Survey, Vol. VIII. Iron Ores: Hematites of West Cumberland, Lancashire, and Lake District. Paper covers, octavo, 182 pages, illustrated. Price 9s. net. London: Edward Stanford, Ltd.

After many years! The geological survey of these districts was commenced about 48 years ago. The map of the northern part of Furness, where the orebodies occur, was published in 1877, and the Whitehaven map in 1892, but the latter was so indifferently done that, in consequence of representations by myself in the early part of 1894, it had to be recalled and revised. The Furness map ought to have been similarly treated at the same time, but unfortunately was not. The Whitehaven map, after revision, agreed to a large extent with that prepared by myself as it appeared in "Iron Ores of Great Britain," published in 1893. The notes from which that map was made were placed at the service of the revising geologist, so that he was able to do in a few weeks what his predecessor had failed to do in more than twenty years.

Until the Memoir under review appeared, the Survey had practically ignored the existence of iron ore in these most important districts. Any stranger looking at the Furness map would never suspect that the district has such an important mining history. The neglect on the part of the Survey is the more to be regretted because results of a careful and systematic study by a trained geologist might have been of the greatest value to the country, by pointing out to miners, who have not as a rule had a geological training, where to look for ore, thereby putting them on the shortest, cheapest, and most likely road to increased production, so greatly needed by us for the last forty years, as shown by our dependence on the ores from Bilbao and other districts abroad. The Survey may be accused of neglect in this respect because it is obviously their duty to do such work. Besides, a Government Geologist can obtain information in a general investigation of this kind which would be denied to most private inquirers, and therefore he has a better chance of getting at the true geological structure, which is of the greatest importance in searching for hematite.

The Memoir ought to have appeared forty years ago, when the writer of it could have thoroughly examined the many magnificent deposits then being worked, and obtained from them a fund of practical information with regard to their nature and distribution which a present-day investigator cannot possibly acquire, the deposits being much less numerous now and not so varied in character. The Memoir teems with references to abandoned mines (most of them working forty years ago), but many of the statements relating thereto are inaccurate and misleading, as will be partly pointed out in the sequel. A visit to the Home Office, where many of the old plans are kept, would have greatly reduced these defects.

Scientific guidance in exploration such as is afforded by an accurate geological map is more needed since the great drop in production that has taken place in Furness. The output of that district in 1882 was about 1,400,000 tons. In 1915 it was only about 320,000 tons. This serious decline is not indicative of early and complete exhaustion, but merely of the working out of *known* deposits. There is much ground that has not been properly explored and still more in which exploration of any kind has not been attempted, although the prospects in both are most encouraging. The private ownership of royalties is partly responsible for the latter, such ownership too often meaning the locking up of unworked areas, the imposition of unfair royalties, wayleaves, and unreasonable conditions of working, the last being particularly objectionable in the development stage. If minerals were nationalized and the laws relating to them more or less assimilated with those prevailing in some of our Overseas Dominions, we should soon have an upward trend in production without the help of a Geological Survey, although at an excessive cost, but with a reliable survey in addition the quicker and less costly results would be greatly surprising. This reference to the nationalization of *minerals* must not be looked upon as an advocacy of the nationalization of *mines*. Far from it. One does not like to think of what would happen to our mining industry if it fell into the hands of a dilatory and non-progressive Government Department, without competition to spur it into business-like activity. The value of a knowledge of structural geology is so appreciated in the United States that some large mining and metallurgical companies have trained geologists on their staffs.

Vol. VIII. will not help in the further development of either district, because it fails to point out in a necessarily emphatic way the intimate association between ore deposits and certain prominent features of geological structure. In many cases, in addition, the structure has been incorrectly interpreted. So far as the writer of the Memoir is concerned this may, to some extent, be due to his inability to examine many of the old mines. It is quite impossible for anyone to unravel the complicated structure of such districts as those now dealt with by merely walking over the surface; the mines, their plans and sections must be examined thoroughly, and that does not appear to have been done even in the fewer mines now open, for the drawings of deposits, by which the Memoir is illustrated, appear to be mostly the work of engineers not connected with the Survey, and further, those drawings have been adopted by the writer of the Memoir without due care, for it can readily be seen that many of them are incorrect, as will be pointed out later.

The primary object of a Geological Survey should be to point out the mineral resources of the country and to aid in their development. Matters of scientific interest only can well be left in the hands of members of scientific societies. Metallic minerals generally occur in a much more complicated manner than coal and therefore need greater attention from the geological surveyor, but they have not received it, and we are in consequence much more indebted to other countries than we ought to be for our supply of metallic minerals. It is not sufficient to make a geological map of such districts as these and then leave it for years without revision, when all the while new developments are being made and additional facts unearthed which ought to be recorded and employed as guides to further exploratory operations.

Having said so much from a general standpoint, it may be well to enter somewhat into detail. In doing this my remarks will be as brief as possible, and will be made under two heads, first as to matters of fact only, then as to questions in which opinion is more or less involved.

In noticing the inaccurate descriptions of abandoned mines in the Whitehaven district the remarks will be confined to those in the neighbourbood of Salter and Eskett Park, referred to on page 115. The Memoir there reads: "The Eskett or Eskett-Park iron ore mines, south-east of the Margaret mines, are abandoned." In this sentence the Memoir ignores the fact that the Eskett Park mines were altogether different and quite apart from the Eskett mine. We then read: "At Winder Gill mine the ore occurred at shallow depth in the first Limestone beneath the Millstone Grit roof." A section of this mine is given in my paper on "The Formation of Ore-bodies,"* from which it will be seen that there was not any ore obtained from the first and second Limestones, but that it occurred in the 3rd, 4th, 5th, and 6th Limestones (third, fourth, and fifth of the Memoir). Further, the ore did not occur at shallow depth. The mine was one of the deep mines of the district, the deepest workings being 672 ft. from the surface. In referring to the Salter Hall mines the Memoir reads: "On the west side of the fault there are two thick flats in the fourth and fifth limestones." There was a flat on the up-side of the fault, at shallow level, in the Eskett Park mine adjoining, but the two thick flats referred to were in Postlethwaite's Eskett. Again, in describing the ore-bodies at Lindal Moor, in Furness, the Memoir is very incomplete and inaccurate. We are told that "the chief body was the famous Lindal Moor 'vein' trending from N. 25 W. to S. 25 E. for about 1,000 yards. It occurs alongside a series of three or more faults that dip to the north-east." The facts are as follow. The dip of the faults is to the S. W. not N. E. Moreover, the above description applies only to the mine as it was 38 years ago. Since then much has been done, several other deposits worked and abandoned.

*Trans. Canadian Mining Institute, vol. xxi., 1918.

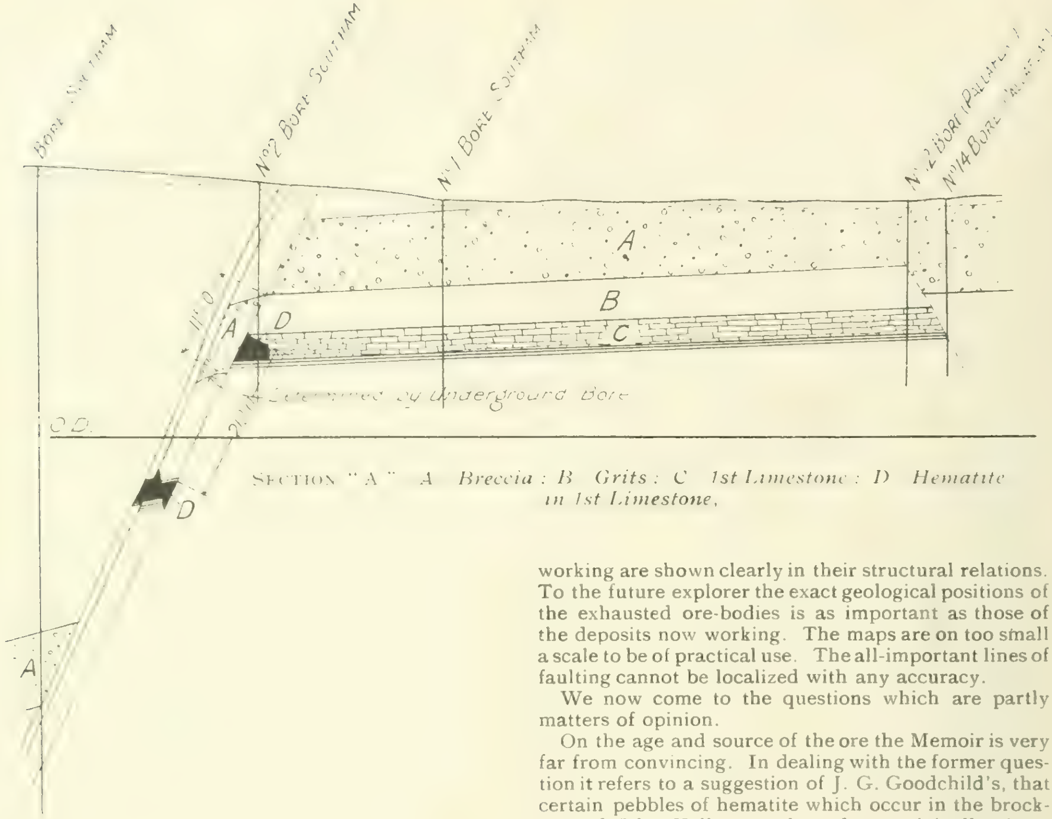
The sectional drawings accompanying the Memoir are not made with the care necessary in an investigation of this kind, nor to a sufficiently large scale to show the necessary details. Special reference is made on page 32 to Figs. 3, 4, 6, and 8, as sections on which an important conclusion is based. Reference will therefore be made to those four only. Figs. 3 and 4 show the Permian Breccia as conformable to the Carboniferous Limestone, but, as is well known, it is unconformable. Moreover, the data employed in the construction of these two drawings are quite insufficient, so far as appears, leaving too much to the imagination. Fig. 6 has also suffered for the latter cause, but it has in addition been carelessly made. It shows the fault on the south-west of Helder Pit to have lifted the Carboniferous Limestone more at the top than at the bottom, which is impossible. Fig. 8 is also incorrect. The beds adjoining the Southam fault do not dip steeply as shown in that figure, but go right up to the compound fault almost level, and the fault is not so steep as shown in Fig. 8.

On page 11 it is stated that "Seven Limestones were recognized by J. D. Kendall, but it is now usual to consider the third and fourth beds as one." In my paper on the Carboniferous Rocks of Cumberland and North Lancashire,* which the writer of the Memoir does not appear to have seen, as it is not included in his bibliography, I state on page 106, in describing the third limestone: "In the 'Hematite Deposits of West Cumberland'† this bed is included with the bed immediately below (now the fourth limestone) from which it is divided by only 2½ to 6½ ft. of shale, but as this shale-bed, although thin, is very persistent, it is more convenient, as well as more correct to consider the limestones between which it lies as separate beds." That opinion is still justified; the separate existence of the third bed can be established on precisely similar grounds to that of the others.

On page 32 the Memoir reads: "In the chief ore-bearing post-Triassic faults the amount of displacement in the New Red rocks is as great as in the Carboniferous Limestone (Figs. 3, 4, 6, and 8), and we know of no certain case in which an ore-body has been faulted since the time of its formation." With regard to the first part of this quotation, the statement is quite wrong. If Fig. 8, to say nothing of the others, had been correctly drawn, the error would have been evident. Herewith is given a section "A," not far from Fig. 8 and nearly parallel to it, made when I was manager of the Southam mine, and consulting engineer of the Pallaflat mine, over twenty-six years ago; also another "B," between "A" and Fig. 8. From these sections it will be seen that in the two cases where the throw of the faults can be determined, the displacement of the Carboniferous Limestone is greater than that of the Breccia. In Wet Croft, west of Egremont, there is a fault which throws the Limestone 430 ft., but the Breccia only 320 ft. Many other sections could be mentioned in which such differences occur, but particular reference will be made to one more only, at the opposite end of the district. By a fault which is parallel to the Yeathouse fault, and east of it, the Carboniferous Limestone is uplifted 485 ft., while the overlying Breccia has been raised only 120 ft. But apart from these particular proofs of late Carboniferous or early Permian faulting, it is quite clear that the Carboniferous beds between Rowrah and Southam, as well as in the Egremont district, were both tilted and intersected by both N.W.—S.E. and N.E.—S.W.

* North of England Institute of Mining and Mechanical Engineers, vol. xxxiv., 1884.

† Ibid, vol. xxviii., 1879.



SECTION "A." A Breccia: B Grits: C 1st Limestone: D Hematite in 1st Limestone.

faults before the Breccia was laid down, or they could not have underlain the Breccia at a higher angle as they do. That fact alone is sufficient to establish the late Carboniferous or early Permian age of N.W.—S.E. or younger faults, which the Memoir persists in describing as post-Triassic. That some faults are of that age is not disputed, but they have come into existence since the ore was formed and may or may not intersect ore-bodies. The compound fault at Ullcoats is partly late Carboniferous or early Permian and partly post-Triassic.

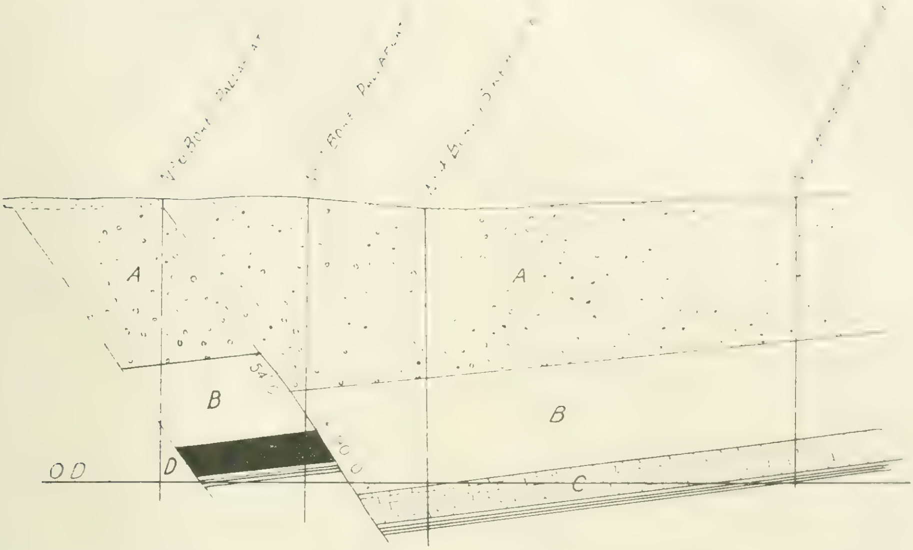
The statement that the writer of the Memoir does not know of any certain case in which an ore-body has been faulted since its formation is not surprising. I know of several instances, but the facts were only ascertained by careful searches with that object in view in a wide experience of the districts extending over many years. To mention one case only, the abraded material on the Salter and Eskett fault contained numerous pieces of hematite in Postlethwaite's Eskett mine, as well as slickensides on the ore. The later faults (those roughly N.W.–S.E.) are therefore in most cases on this kind of evidence not post-Triassic as stated in the Memoir, but they have had one or more differential movements since Triassic days.

The geological maps in the Memoir follow to a large extent the revised Whitehaven map and the Furness map published in 1877. The former omits all the old and most important deposits, the latter shows very few of the faults occurring in that much-faulted district, while some faults are shown which do not exist Few of the old ore-bodies are shown and none of those working are shown clearly in their structural relations. To the future explorer the exact geological positions of the exhausted ore-bodies is as important as those of the deposits now working. The maps are on too small a scale to be of practical use. The all-important lines of faulting cannot be localized with any accuracy.

We now come to the questions which are partly matters of opinion.

On the age and source of the ore the Memoir is very far from convincing. In dealing with the former question it refers to a suggestion of J. G. Goodchild's, that certain pebbles of hematite which occur in the brockram of Eden Valley may have been originally pieces of limestone in the brockram which subsequently were replaced by hematite. If that suggestion is correct the pieces of hematite are younger than the formation in which they occur. I discussed that question with Goodchild over thirty years ago, and invited him to visit the Whitehaven district to see the fragments of hematite there found in the Breccia, so large and numerous compared with those occurring in the valley of the Eden, and moreover occurring in such a way as to preclude the possibility of their being replacement products since they became part of the Breccia. Pieces of pure hematite occur alongside pieces of pure limestone, which is most unlikely to have happened if a replacement process had ever been at work in the Breccia. Moreover the surface of many of them is polished in places. Unfortunately Mr. Goodchild did not accept the invitation. He was practically a stranger to the iron-ore fields, and an acquaintance with them would, almost certainly, have altered his opinion.

The suggestion of the Memoir that the source of the ore was *above* is likewise unsupported by facts. On page 31 of the Memoir we read: "That the solutions were introduced from above is inferred from a large number of cross-sections of vein-like bodies with flat-like extensions. The thickest and best ore is usually concentrated at the junction of the vein and flat, and in the fault-plane the extension is often upward." The maximum thickness being at the junction of the veins and flats is surely an indication that the source was *below*. If the replacing solution emerged from below along the fault, it would attack the rock at the junction more vigorously than either up the fault



SECTION "B."—A Breccia : B - Grits : C = 1st Limestone : D Hematite in 1st Limestone.

or along the flats, but there would be no reason for its doing this if the solution descended. The upward extensions are mainly those from the flats at the bottom of the 7th Limestone, where an extension downward is impossible, there being no limestone to replace.

Again, on the same page it is stated that: "Perhaps the best evidence that the percolation was downward is afforded by the location of the flats and irregular bodies of ore. Where the whole of the limestone is present, the ore-bodies away from the outcrop tend to cluster some distance above the base of the series, and especially when the Millstone Grit and Coal Measures come between the Limestone and the brockram. Where, on the contrary, the higher beds of the Limestone have been cut out by the brockram, ore-bodies may occur at any depth down to the base of the series."

The facts, as thus stated, are approximately correct, but that they indicate an origin by downward filtration does not follow by any means. Let us look into the then far-distant past for a while. There is abundant evidence in the Cumberland coalfield that about the close of the middle Coal Measure period powerful crust movements took place by which the coalfield and adjacent country were uplifted several hundred feet. A period of severe denudation followed. The country was then lowered and the upper Coal Measures laid down. Some time later a further elevation occurred, followed by more denudation, so that when the Breccia was deposited the Carboniferous Limestone and Grits had been much faulted and tilted. On the eroded edges of these rocks the Breccia was laid from Rowrah to Southam, but in the neighbourhood of Egremont it was deposited on the lower Limestones, the Grits and upper Limestones having been removed.

If the ore deposits were formed by downward filtration as the Memoir suggests, why do we not find some of them in the Magnesian Limestone or at least find that rock much discoloured by iron, and why were the circulating waters confined to lines of late Carboniferous or early Permian faulting? Further, there is no evidence of leaching of the overlying Red Rocks. They are quite as red adjacent to the faults as they are at any distance away from them. One would expect from downward filtration that the upper part of the Limestone, immediately below the Breccia, would have intercepted the descending waters and have been converted by them into extensive layers of hematite. Instead of that we find the ore-bodies in the Whitehaven district, where the Grits are on, in the first and second or in the third and fourth Limestones; and where the lower Limestones only occur below the Breccia, the ore-bodies are mainly in the 7th Limestone, partly at the bottom of it and partly extending upward on the fault planes, but mostly with a thick covering of Limestone.

At Lindal Moor, in Furness, several of the ore-bodies occur in a similar position to those at Egremont, down on the Lower Limestone Shale and partly upward therefrom, along intersecting faults, but in every case they are overlain even now, after severe denudation, by 100 to 200 feet of limestone. Surely this does not indicate downward filtration. The reddish colour of the greater part of the Cumberland Coalfield is also attributed by the Survey to downward filtration. A large part of those Measures is shale, which is impervious to water under ordinary pressures and therefore could not be stained in the way suggested. The colouration is much more likely to be due to subterranean disturbances by which ferric oxide or some other combination of iron was ejected from below and afterward commingled with the argillaceous and silicious matter forming the shales and sandstones. The paler colour is probably due to the smaller quantity of iron ejected during the initial disturbances as compared with that which afterwards supplied the colouring matter of the New Red rocks. Some time during these disturbances, in all probability, the ascending iron solutions which formed the ore-bodies were produced.

The reason of the distribution of ore in depth, as above described, is a question which cannot be entered upon here for want of space. I have, however, dealt with it in a paper on "The Formation of Ore-bodies," printed in the Transactions of the Canadian Mining Institute, vol. xxi., 1918.

On page 48 of the Memoir suggestions are made as to where hematite might be found, and there we read: "The Limestone near Cark might yield ore if the proximity of the New Red rocks be taken as a guide. Trials, of the results of which we have no knowledge, were made at Allithwaite, 1½ miles east of Cark, about 1856-62." Further trials on a large scale were made by the Maryport Iron Company in the seventies, but without finding a workable deposit of ore, notwithstanding the proximity of a large mass of New Red rocks.

Very much more might be said with reference to this Memoir, but the remaining scientific issues must go unnoticed, as they are of much less moment at present than the technical and commercial questions.

The money at the disposal of the Survey would be well spent in a closer and more practical study of these two important districts. If further money is required the nation would do well to provide it. If the mineral laws were altered as above suggested, private enterprise would soon provide the geological data.

J. D. KENDALL.

Manual of the Chemical Analysis of Rocks. By Henry S. Washington. Third edition, revised. New York. John Wiley & Son; London: Chapman & Hall. Price 11s. 6d. net.

Since 1904, when the first edition of this invaluable book appeared, chemists and petrologists throughout the world have had ample opportunity to realize their indebtedness to its author. Dr. Washington writes with unrivalled authority on his subject, for he is himself one of the leading rock-analysts in a group of perhaps a dozen men who have made their name famous in this branch of research. He has lately published a compilation of some 10,000 analyses of igneous rocks *(U.S.G.S. Prof. Pap. 99)*, and the completeness and reliability of a large number of these are doubtless due in large measure to the influence of his Manual. The name of Hillebrand will of course always stand pre-eminent in this connection, but despite the just renown that Hillebrand has won as an exponent of accuracy, it is probable that his publications have not been used in the laboratory to the same extent as that of Washington. The superiority of the latter from the practical point of view is that it describes with meticulous care the many details of manipulation and precaution which must be followed in order to achieve success.

The present edition has been considerably enlarged, and its value is correspondingly increased. Throughout the book the possible sources of error in operations and methods are revealed, and as a result the book is one which can be used by any intelligent post-graduate student, even if he be obliged to work without personal instruction or supervision.

Dr. Washington is not only a chemist; he is also a very influential petrologist, and for that reason he is thoroughly familiar with every aspect of the materials whose analysis he describes. As a result, he sees in rock-analysis more than a mechanical repetition of certain stereotyped methods. He shows the subject in its true perspective as a system of research, and not merely as one of more or less skilful routine. The book has already made a wide appeal in its earlier editions, and many of those who have used it well will be glad to replace its laboratory-stained pages by a copy of the revised edition now issued. Those to whom the book is new will find it of immeasurable service as a guide to the qualitative inorganic analysis of silicate materials in general, whether the latter be minerals, rocks, or commercial products.

ARTHUR HOLMES.

COMPANY REPORTS

Simmer & Jack.—This company belongs to the Consolidated Gold Fields group, and was formed in 1887 to acquire property on the outcrop to the east of the central Rand. The report for the year ended June 30 last shows that 605,900 tons of ore was raised and treated for a total yield of gold of 158,281 oz., worth £665,849, or 21s. 11d. per ton. The working cost was £603,275, or 19s. 11d. per ton. A dividend of £37,500, at the rate of 1¼%, was paid. The ore reserve is estimated at 1,318,000 tons averaging 5.83 dwt. per ton. Increasing proportions of ore in the future will come from the 40 claims acquired from Simmer Deep. The amount of ore obtainable by reclamation in old workings is uncertain.

Luipaard's Vlei Estate and Gold.—This company was formed in 1888 by the Consolidated Gold Fields to work a gold-mining property in the west Rand. Milling was started in 1898, but was suspended by the Boer war, and was not resumed until 1906. In 1909 the adjacent Windsor mine was absorbed. In 1912 the control passed to L. Ehrlich & Co. The property consists of four sections, two on the Main Reef Series, and two on the Battery Reef to the south. Small dividends were paid in 1908, 1909, and 1916. The report for the year ended June 30 last shows that 301,025 tons of ore was raised, and after the removal of waste, 244,120 tons averaging 5.2 dwt. per ton was sent to the mill. The yield by amalgamation and cyaniding was 59,827 oz., worth £250,127, or 20s. 6d. per ton. The working cost, including development redemption, was £259,980, or 21s. 3d. per ton, so that the year's work resulted in a loss. It is expected that the present premium on gold will put the company on a sounder footing. In the meantime debenture holders have agreed to the suspension of redemption. Of the ore mined during the year, 56.2% came from the Main Reef, 18.8% from the South Reef, and 18.5% from the Battery Reef, and the remainder from development. The reserve is estimated at 713,870 milling tons averaging 5.32 dwt., an increase during the year of 68,836 tons but a fall of 0.19 dwt. in grade. Of this reserve 382,445 tons averaging 5.34 dwt. is in the Main Reef, 275,298 tons averaging 5.31 dwt. in the South Reef, and 56,127 tons averaging 5.19 dwt. in the Battery Reef.

Van Ryn Gold Mines Estate.—This company was formed in 1892 to acquire property on the outcrop in the Far East Rand. Sir George Albu is managing director. The report for the year ended June 30 last shows that 414,601 tons of ore was raised, and 400,860 tons sent to the mill. The yield of gold by amalgamation was 67,248 oz., and by cyanide 29,229 oz., making a total of 96,477 oz., equal to 4.81 dwt. per ton. The accounts show an income of £402,785, or 20s. 1d. per ton, and a net profit of £53,130, out of which £50,000 has been paid as dividend, being at the rate of 10%. The ore reserve is estimated at 1,287,520 tons, averaging 5.7 dwt. per ton.

Rooiberg Minerals Development.—This company was formed in 1908 to work tin lodes in the Waterberg district of the Transvaal, due north from Pretoria. A new dressing plant was erected in 1912. Dividends were paid from 1910 to 1917. In the latter year the adjoining Blaauwbank property was acquired. The report for the year ended June 30 last shows that owing to ore supplies becoming restricted milling was suspended in May. During the year 9,299 tons of Rooiberg ore was sent to the mill, together with 5,309 tons from Blaauwbank, and 341 tons from dumps. The average content of mill-feed was 1.6% metallic tin.

In addition 11,190 tons of accumulated slime averaging 1·09% tin was re treated. The yield of concentrate was 350 tons, averaging 65·85% tin, the percentage of recovery being 75. At the close of the year 2,350 tons of ore was stacked ready for treatment. Alluvial operations resulted in the extraction of concentrate containing 7·36 tons of metallic tin from 19,557 tons of sandy material. The revenue was £54,687, and the working cost was £70,178. Though no ore from the mine is being milled at present, the accumulations of slime and middling are being treated. Development is being actively prosecuted.

Cape Copper.—This company has worked copper mines in Little Namaqualand, Cape Province, since 1863. It ships ore and matte to Britonferry, South Wales. The company has more recently developed a copper property at Rakha Hills, Chota Nagpur, India. The report for the year ended April 30 in the Cape and August 31 in London and India has been published The prohibition of shipment of ore and matte during the latter end of war brought a crisis to the Cape mines, and though mining and smelting was carried on for a while, operations had to be suspended owing to the subsequent fall in the price of copper and to the high cost of labour and supplies. Smelting has been suspended at Britonferry. During the year, 5,599 tons of ore, averaging 12·37%, was raised at O'okiep mine, and 19,931 tons, averaging 4·64%, from the Nababeep South. At Rakha Hills the converter plant started in December last, and the refining in July. No copper was brought to market during the year, and a loss is shown of £171,006.

Taquah Mining & Exploration.—This company was formed in 1888, as the Taquah & Abosso Gold Mining Co., to acquire gold-mining properties in the Gold Coast Colony, West Africa. In 1901 the company was split, the Abosso being transferred to a separate company. The control passed to the Oceana Consolidated in 1910, and additional capital was then provided for development. Dividends have been paid since 1914. The report for the year ended June 30 shows that 59,213 tons of ore was raised and treated, averaging 58s. 6d. per ton. The yield of gold by amalgamation was £143,910, and by cyanide £25,274, making a total of £169,184, or 57s. 3d. per ton. The profit was £51,204, out of which £48,434 has been distributed as dividend, being at the rate of 12½%. The working cost per ton shows a slight reduction. The ore reserve is estimated at 210,406 tons, averaging 54s. 9d. per ton, as compared with 213,469 tons, averaging 57s. per ton, the year before. G. W. Campion, the manager, reports that development must be increased, but that present scarcity of labour stands in the way. He is of opinion that some of the labour ought to be diverted from stoping to development work even if the output has to be reduced.

Abosso Gold.—This company is a subsidiary of the Taquah, particulars of which are given in the preceding paragraph. The report for the year ended June 30 shows that 80,075 tons of ore, averaging 34s. 8d. per ton, was sent to the mill, where gold worth £132,027 was extracted, equal to 32s. 11d per ton. The working cost was £130,364, or 32s. 6d. per ton, but after the deduction of allowances for depreciation, etc., a net loss of £6,332 was incurred, bringing the total indebtedness to £17,934. The ore reserve at June 30 was estimated at 285,250 tons, averaging 33s. 6d. per ton. Development since the date of the report has given better results, and the directors are now able to declare an interim dividend of 1s. per share for the current year.

Northern Nigeria (Bauchi) Tin Mines.—This company was formed in 1910 to acquire alluvial tin ground at N'Gel, in Nigeria, from the Anglo-Continental Mines. An account, written by A. R. Canning, the manager, was published in the Magazine for February, 1918. The report for the year ended June 30 last shows that the output of tin concentrate was 365 tons, as compared with 535 tons the year before, the fall being due to shortage of labour, owing partly to the influenza epidemic. The accounts show a profit of £12,333, which was carried forward. An interim dividend of 5% on the preference shares has been declared for the current year. Prospecting and testing have been carried on as vigorously as the supply of labour would permit, and the proved reserve of ground was estimated at June 30 to contain 7,956 tons of recoverable cassiterite, as compared with 7,324 tons the year before. The construction of the Kwall Falls hydro-electric power station has been commenced, and the diversion of labour to it accounts partly for the fewer hands available for mining and testing Additional prospecting licences and options have been acquired during the year.

Jantar Nigeria.—This company was formed in 1912 to work alluvial tin ground near Naraguta, Nigeria. H. D. Allen is manager, and Oliver Wethered, Percy Tarbutt, and E. W. Janson are the directors. The report for the year ended September 30 shows that the yield of tin concentrate was 110 tons, as compared with 166 tons the year before, the fall being due primarily to shortage of labour supply. The accounts show credits of £18,287, and a net profit of £995, the latter comparing with £15,216 the year before. During the year additional areas have been acquired at Kuru from the Niger Co., and the capital was increased from £60,000 to £90,000 to provide the purchase price and necessary working capital. Tin winning has already been commenced at one of the new areas, and the output is expected to be maintained at not less than 20 tons per month.

Benue (Northern Nigeria) Tin Mines.—This company was formed in 1910 to acquire alluvial tin properties in the Zaria district of Nigeria. Operations were started with a bucket-dredge, but on the ground being proved to be unsuitable for this method of treatment, the dredge was sold and the calabashing system was adopted. The report for the year ended July 31 shows that the output of tin concentrate was 89 tons, as compared with 192 tons the year before. The accounts show a profit of £2,788, and £3,000 has been distributed as dividend, being at the rate of 5%. An option has been secured on tin-bearing ground near Jemaa, and an examination is now being made.

South Bukeru (Nigeria) Tin.—This company was formed in 1910 to acquire alluvial tin property in Nigeria, and other properties have been acquired since. S. R. Bastard is chairman, C. G. Lush is consulting engineer, and H. C. Blee is manager. The report for the year ended June 30 last shows that the output of tin concentrate was 53 tons, as compared with 112 tons the year before, the fall being due partly to the scarcity of labour and partly to the necessity for further prospecting and development. The accounts show an income of £8,304 from the sale of concentrate, and a loss of £1,131.

Kamunting Tin Dredging.—This company was formed in 1913 by F. M. S. Timah, Ltd., to acquire a tin dredging property in the Larut district of Perak, Federated Malay States. The report for the year ended June 30 last shows that 836,500 cu. yd. was treated by the dredge for an output of 323 tons of tin concentrate. The yield was 0·86 lb. per yard, the working cost 5·379d. per yard, the total cost 7·8d. per yard, and the income 12·5d. per yard. The revenue was £43,669 and the profit £16,776. After allowance for income tax, £7,828, the net profit was £8,948, out of which £6,500 has been distributed as dividend, being at the rate of 5% free of income tax. It is now proposed to acquire an additional area in the same district and to erect two new dredges. For this purpose 130,000 new shares of £1 each are being offered to shareholders at 30s. each.

Sulphide Corporation.—This company was formed in 1895 to acquire the Central mine at Broken Hill. The Minerals Separation flotation process was largely developed there. The company owns a lead smelter at Cockle Creek, near Newcastle, New South Wales, and a zinc smelter at Seaton Carew, Durham. The report for the year ended June 30 last shows that 113,457 tons of ore was raised, while 115,401 tons, averaging 14·8% lead, 16·5% zinc, and 12·9 oz. silver per ton, was sent to the concentrating plant. The mill also treated 4,884 tons of ore from the Junction mine, averaging 12·8% lead, 7% zinc, and 9·5 oz. silver, and 9,655 tons of dump slime, averaging 18·9% lead, 21% zinc, and 16·5 oz. silver. The output of lead concentrate was 23,655 tons, averaging 63·7% lead, 9·8% zinc, and 43·4 oz. silver. The output of zinc concentrate was 38,643 tons, averaging 45·7% zinc, 8·8% lead, and 13·7 oz. silver. At the de-leading plant the zinc concentrate yielded 36,650 tons of final zinc concentrate, averaging 47·6% zinc, 6·2% lead, and 12·5 oz. silver, and 1,791 tons of lead concentrate, averaging 62·1% lead, 12·3% zinc, and 39 oz. silver. Owing to the short supply of ore from the mine, due to scarcity of labour, arrangements were made to treat dump slime by adding it to the mill feed. Development at the 1,400 ft. level has been disappointing, and drill-holes sunk below this level have failed to indicate the presence of any considerable body of ore. The ore reserve is estimated at 1,506,950 tons. At the smelting works, 85,324 tons of material was smelted, no details as to the relative proportions of mine concentrate and purchased material being given. The output of the refinery was 22,935 tons of soft lead, 359 tons of antimonial lead, 17,599 oz. of gold, and 2,127,082 oz. of silver. At the zinc works 7,204 tons of concentrate was roasted, and 8,256 tons of roasted ore was smelted, yielding 2,484 tons of zinc, 77 tons of zinc dust, and 10 tons of lead. The retort residue was put on the dump. The accounts show sales £1,973,708, and a profit of £308,508, out of which £157,500 has been distributed as dividend, being at the rate of 15% on both ordinary and preference shares. The remainder is kept in hand owing to the strike at Broken Hill.

Mount Elliott.—This company has its headquarters in London, and operates a number of copper properties in the Cloncurry district of Queensland. W. H. Corbould is the general representative and consulting engineer. The report for the year June 30 last shows that difficulties in connection with the shipment of copper made it necessary to cease smelting, and that operations were thus confined to 7½ months out of the twelve. During this time 61,975 tons of ore was smelted, for a yield of 2,884½ tons of refined copper, and the accounts showed a loss of £41,034. During the previous year a loss of £56,890 was made, owing to labour troubles. At the present time the directors are in negotiation with Hayden, Stone & Co., with a view of obtaining capital to develop the properties on an adequate scale. The present ore reserves are estimated as follows: Mount Elliott, 600,000 tons averaging 3%, and 4,000 averaging 10%; Consols, 450,000 tons averaging 4%; Great Australia, 110,000 tons averaging 2½%, and 93,000 tons averaging 4%; Dobbin, 41,000 tons averaging 5%; Mount Oxide, 300,000 tons averaging 10%; Argylla, 200,000 tons averaging 4%; Lady Leases, 28,000 tons averaging 5%; Crusader, 50,000 tons averaging 5%. At the Mount Oxide, which is worked through a subsidiary company, the cutting of the lode at the 300 ft. level has been an important feature, proving the continuance of the wide ore-body in depth. At the Crusader, the prospecting operations have given excellent results. The Consols mine contains very large quantites of ore that could be worked on an extensive scale.

Menzies Consolidated Gold Mines.—This company was formed by C. Williamson Milne in 1895 to acquire gold-mining properties at Menzies, West Australia. R. Goninon is manager. The capital is £224,015, and the only dividends paid were for the four years 1914 to 1917, during which 2½% per annum was paid. The report for the year ended July 31 last shows that 24,384 tons of ore was treated, yielding gold worth £49,904, while the costs were £48,756. In addition £2,852 was written off for depreciation. The ore reserve is estimated at 83,562 tons averaging 34s. 11d. per ton, as compared with 103,767 tons averaging 35s. 9d. per ton the year before. Developments at depth have been disappointing. The manager recommends that the main shaft shall be sunk and the lode attacked from a 19th level in the hope that better ore will be found.

Santa Gertrudis.—This company was formed in 1910, as a subsidiary of Camp Bird, Ltd., to acquire a silver mine at Pachuca, Mexico. The report for the year ended June 30 shows that conditions have returned to normal after the dislocation caused by the war. During the period 362,122 tons of ore was treated and bullion containing 24,359 oz. gold and 4,304,812 oz. silver was produced. The gross value of the output was £1,037,606. The profits remitted to this country were £200,000, out of which £150,000 has been distributed as dividend, being at the rate of 10%. The reserve of ore is estimated at 718,579 tons and the recoverable content 40,168 oz. gold and 7,128,996 oz. silver. As recorded in August, 1918, the company has acquired interests in the El Bordo, Malinche, and El Cristo properties in the same district. It is expected that the delivery of ore from El Bordo will be commenced in September next. The development of the Malinche property is being actively carried on.

El Oro Mining & Railway.—This company belongs to the Exploration Company group, and was formed in 1899 to acquire a gold mine at El Oro, Mexico. The report for the year ended June 30 shows that the amount of ore treated was 308,717 tons, and the receipts were £526,697. The profit was £69,779, out of which £57,375 has been paid as dividend, being at the rate of 5%. The ore reserve is calculated at 333,135 tons, averaging $13·80 gold and 3·17 oz. silver per ton, as compared with 292,379 tons the year before. Funds are now being accumulated from revenue with a view of acquiring other properties at El Oro.

Tolima Mining.—This company was formed in 1871 to acquire the Frias silver-lead mine in Colombia, South America. In the early days the operations were highly profitable, but in 1903 and 1909 reconstructions were necessary in order to provide funds for development. During the war and since great difficulty was experienced in shipping ore and getting it smelted. The report for the year ended June 30 shows that 8,420 tons of ore was raised, and that 455 tons of concentrate was produced, averaging 15·57% lead and 406 oz. silver per ton. The reserve is estimated to yield 1,146 tons of concentrate. The accounts show an income of £13,339 from sales and credits of £75,311 for concentrate still unrealized. The net profit was £2,533, against which there was an adverse balance of £2,482 brought forward from the previous year.

The Mining Magazine

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CONTENTS.

EDITORIAL

ELSEWHERE we record the bestowal of the Gold Medal of the Institution of Mining and Metallurgy on Mr. H. L. Sulman, in recognition of his contributions to metallurgical science, with special reference to his work in the development of flotation and its application to the recovery of minerals. The Institution also announces the award of the Consolidated Gold Fields of South Africa gold medal to Mr. W. H. Goodchild for his papers on the economic geology of the Insizwa Range and the genesis of igneous ore deposits; and of the Consolidated Gold Fields premium of forty guineas to Dr. E. T. Mellor for his paper on the conglomerates of the Witwatersrand.

SIMPLIFIED spelling is once more to the fore among American mining engineers, owing to Mr. W. H. Shockley's pleasant persistence. The Institute is to take a ballot of all its members as to whether the new spelling shall be adopted in its publications or not. The Institute's board of directors has issued a negative statement, to go out with the ballot papers and Mr. Shockley's argument. It is the general view of engineers in America and here also that the function of a technical society and of technical publications is not to agitate for simplified spelling, or for that matter even to act as teachers of good grammar and syntax otherwise than by example. As far as this Magazine is concerned, we have already given our reasons for refusing simplified spelling at any price, and our determination to adhere to the Oxford Dictionary.

A regrettable incident has happened in connection with the interpretation of the geology of the Celebration mine at Hampton Plains Block 50. As readers are aware, Mr. C. S. Honman wrote a bulletin six years ago for the West Australian Geological Survey on the geology of the region south of Kalgoorlie. On the discovery of the deposit now known as the Celebration, Mr. A. Gibb Maitland, Government Geologist, issued a statement explaining the formation in which it is found, and drawing inferences as to its correlation with the formation at Kalgoorlie, basing his conclusions on the facts and views contained in Mr. Honman's bulletin. In the meantime Mr. Honman returned to West Australia from his war work, and was commissioned by the Celebration people to make a further examination of the district. As a result he believes that the line of lode is similar to the Horseshoe-Boulder-Ivanhoe lodes. Mr. Maitland had deduced from Mr. Honman's bulletin that the lode corresponds with that of the Kalgurli mine. As we pointed out in the November issue, the correct correlation is a matter of some importance, for the Horseshoe - Boulder - Ivanhoe lodes are in quartz-dolerite only, and are the richest on the field, while the Kalgurli lode is in calc-schist and quartz-dolerite, and though profitable is not of the same even richness. Mr. Honman has issued a statement, which is given by our Kalgoorlie correspondent elsewhere in this issue, taking his former chief to task for interpreting the bulletin incorrectly, and denying the presence in the bulletin of any evidence warranting the assumption that the Celebration lode corresponds to the Kalgurli lode. We deprecate this public method of geological controversy, for it only obscures the real question by raising a cloud of bitterness. Until further unprejudiced information and argument are to hand, it is desirable to postpone discussion of this interesting geological problem.

NITROGEN from the air has been one of the war problems of this country, not so much from the point of view of the chemical engineer, but by reason of the difficulty of pushing even a germ of the idea into the heads of those in authority. Turning to the files of the Magazine for 1913, we find that the various processes were perfectly well known at that time to those interested in the subject: the Birkeland-Eyde direct electric nitric acid method, the Frank-Caro cyanamide process, the Ostwald conversion process, the Haber compression method, and the Serpek nitride method. For a long time the military and naval authorities imagined that their blockade would effectively bring the German ammunition to an end owing to the impossibility of importing Chile nitrate on the part of the enemy. When they did alter their views, science had to brave the serried ranks of officials who had to learn the elementary principles of the problem, and in their turn pass on the information they had collected to other officials, and so on, not exactly ad infinitum, but precious near it. Finally the naval blockade brought Germany to its knees in other ways, and the Armistice was signed before any productive plant had been completed in this country. The Nitrogen Products Committee has now issued its final report. This is a voluminous Blue-Book of 350 closely printed foolscap pages, containing a mass of technical and commercial information relating to all possible sources of nitrogen. We note with interest some details relating to the less known processes such as the Haüsser explosion method, the cyanide method, and the Bender combustion method. At the same time that this report was published, the Nitrogen Products Co. announced that at its new works in Cumberland the Claude ammonia process is to be adopted, this process being a modification of the Haber process but working at far greater pressures; thus private enterprise gets in front of Government methods once again.

Calloose.

The prospectus of the Calloose Tin Mines & Alluvials, Ltd., was widely advertised during the third week of January. This company has been formed to acquire Mr. Albert F. Calvert's ventures in the Gwinear mining district, southwest of Camborne. A few months ago we wrote in a frankly disparaging manner of the Trevascus lode mine to which Mr. Calvert and Major Bullen first turned their attention, and last month we briefly said that their alluvial venture was equally unconvincing. Now that a public offer has been made of the shares in a company owning lode mines and alluvial ground, we can deal with the matter more in detail.

In the first place it is noticeable that no report by an independent mining engineer of recognized standing is appended to the prospectus. Chief reliance is placed on a report of Major F. Bullen, the general manager, who is a young man of very limited experience. Another report is provided by Mr. Edwin Timmins, who used to be underground manager at East Pool, though he can hardly lay claim to be a "well known Cornish consulting engineer," as he is called in the prospectus. Mr. W. R. H. Hereford, the manager of the Trevascus mine, contributes a report on that property, and Mr. F. J. V. Bullen and Mr. C. J. Reed write on the Calloose lode mines, these gentlemen being manager and underground manager respectively of this group. Mr. W. Brokenshire, mill manager, writes on the plant, as also does Mr. H. R. Beringer, the company's consulting chemist and metallurgist. The alluvial deposits are described by the alluvial manager, Mr. H. Bennetts, who has previously been a prospector in the Cape Province and in Nigeria. It will be seen that all the above-named gentlemen are in the service of the company in one way or another, and that none of them is a man of first-class experience or position.

According to the prospectus and reports the Trevascus lode is 60 ft. wide and 600,000 tons of ore has been definitely blocked out, averaging 22 lb. of tin per ton, there being in addition very valuable by-products in the form of arsenic, zinc, copper, and possibly silver. All this ore is above water-level and can be mined by open-cut. It is estimated that the total ore in this lode above water-level across the whole property is 2,025,000 tons. The open-cut is to be of a depth of 20 fathoms, and it is stated that old miners worked for tin to 72 fathoms.

The Calloose lode group consists of the Wheal Hope, Fraddam, Wheal Providence, and West Wheal Treasury, which are traversed by the Unity and other lodes. The Unity lode is said to have been sampled for 350 ft. to a depth of 90 ft., giving 60 lb. of tin and £3. 5s. in arsenic per ton, over a width of from 1½ ft. at surface to 6 ft. at 90 ft. The Red lode is reported to contain ore averaging 55 lb. per ton at the 10 fm. level, and to be very rich in depth.

The Calloose alluvial tin ground covers 48 acres and averages 8 ft. in depth, with practically no overburden. The average recoverable content is given at 8¾ lb. of tin oxide per cubic yard, and the total at 2,400 tons. Ten sluices have been installed and they are stated to be producing 8½ tons of tin oxide per week, valued at £1,280, at a cost of £370 per week, so that a profit is being made of £910 per week. Additional tin sluices are to be installed, and also pumps and monitors.

The property acquired by the company includes 1,212,000 tons of tailing and ore dumps, the tailing being said to average 12 lb. of tin per ton; also a mill at Wheal Hope, which is in two sections, treating Unity ore and old tailings respectively. At present the tailing plant is capable of dealing with 80 tons per day, and the ore mill contains 8 stamps, to be increased shortly to 23 stamps. It is said that both sections are working at a profit. It is proposed to erect a mill with a capacity of 3,000 tons per month at Trevascus, ultimately to be increased to 10,000 tons.

The capital of the company is £125,000 in shares of 5s. each, and £15,000 6% first mortgage debentures are to be created. The purchase consideration is £110,000, payable as to £30,000 in cash, as to £15,000 in debentures, and as to £65,000 in shares. The present issue offered to the public is 240,000 shares at par, which if fully subscribed will provide £60,000 in cash. It is stated that development and equipment has cost £30,330. The vendor is the General Exploration and Finance

Co., Ltd., acting as agent for Mr. A. F. Calvert.

The above synopsis of the prospectus might be read to indicate that a wonderfully prosperous tin-mining enterprise had been established in Cornwall. There are, however, certain circumstances which take the gilt off the gingerbread. In the first place, no one acquainted with the record of Mr. Calvert as a promoter of mining companies would dream of buying shares; secondly, the statements in or accompanying the prospectus come from comparatively inexperienced men, who are also employees of the company; thirdly, why should £60,000 in shares out of £125,000 be offered at par to the public when profits at the rate of £45,000 per year are being made out of the alluvial property, and profits are also being made from the tailing dumps and the rich lodes, especially as the prospectus says that no large amount of working capital is required at present?

The Calloose flotation provides an appropriate opportunity for once more emphasizing the necessity for establishing some rule or law which will prevent the offering of mining shares to the public unless the prospectus or statement is accompanied by a report made by an engineer of standing. The Institution of Mining and Metallurgy has this object sincerely at heart, as is evidenced by the proposal of the Council for the establishment of a Register of Qualified Engineers, to which reference was made in the Magazine last June. Perhaps Calloose will provide a modern instance that will help on the agitation.

Dartmoor Water-Power.

The project for utilizing the Dartmoor water resources for the purpose of generating electricity has been withdrawn owing to the opposition of the Duchy of Cornwall office and the Devon County Council. This rebuff, coming so shortly after the refusal of Parliament to allow the British Aluminium Co. to use the waters of Lochs Laggan and Treig in Inverness, reflects the disinclination of those in authority to favour hydro-electric schemes in this country. The opposition in this case was based partly on the possible damage to farming due to the withdrawal of the water, and partly on esthetic grounds. Neither of these arguments appears to be substantial. As regards the first, the impounding of the water will not rob the soil of moisture, for it is only excess water that is caught in reservoirs; moreover, the whole of the water will not be taken, so that there will still be sufficient for the cattle and sheep, and the vegetation lining the streams at the lower altitudes will not suffer. From the esthetic standpoint, the dams, pipe-lines, and transmission lines are denounced as eye-sores. It is difficult to give judgment in matters of taste and sense of beauty. The London County Council prefers to employ the clumsy and expensive underground conduit system for its tramways because the overhead wires are ugly, and refuses to avail itself of a comfortable income from advertisements on the sides of the cars for the same reason. On the other hand, the dwellers in North Wales raise no objection to the transmission wires which carry current from the Snowdon lakes across the Gwynant valley and over the mountains to Festiniog, or to the hydro-electric installation of the Aluminium Corporation in the Conway valley; nor does the Cornwall County Council inveigh against the explosives works at Gwithian and Perranporth, or against the transmission lines of the Hayle electric station. It is alleged that the dams for the Dartmoor reservoirs will be blots on the landscape, and the Burrator reservoir which supplies Plymouth with water is cited as a sufficiently horrible object to warrant opposition to the construction of any further engineering works of this sort. On the other hand, the Londoner appreciates the beauty of the Welsh Harp reservoir at Hendon and the Highgate Ponds, and the Manchester man revels in the picturesque at Worsley lake and Whaley Bridge reservoir, both feeders of canals. After all, beauty is relative; some artists go so far as to declare their disbelief in either beauty or nature. As for the construction of these works destroying the romance of Dartmoor, it is surely no unkindness to say that the glamour of the name is somewhat dulled by its association with convict life.

The scheme of the Dartmoor and District Hydro-Electric Supply Company provided for the impounding of the water of five streams rising near the highest point of the land (about 2,000 ft.) and flowing in different directions to the sea. The Dart and Erme flow south, the Tavy south-west, the Teign south-east, and the Taw due north. These rivers would be dammed, and power plants would be erected for each. In addition, the East Dart would be dammed, and also two other tributaries of the Dart. The plan was to supply current for an electric copper refinery to be erected at Newton Abbot, and to sell current to any town in Devon desirous of making a contract. The promoters are all substantial men of business, some of them well known to readers of the Magazine, namely, Sir Gerard Muntz, and Messrs. W. A. Addinsell,

A. E. Parke, J. A. Purves, and H. J. Wilson. Details of the actual control have, however, not yet been published. In default of receiving support for their hydro-electric plans, they are now arranging to rely on the lignite beds at Bovey Tracey, near Newton Abbot, for the power required for the copper refinery. These lignite deposits have recently been described in a Memoir published by the Geological Survey. The author of this report appeared to be rather sceptical of the attractiveness of these deposits as a commercial proposition, but the present conditions in the coal industry have evidently induced the company to think differently. The lignite will not be burnt in a boiler-furnace, but is to be gasified, so that the landscape and the atmosphere will not be spoilt by clouds of black smoke.

In spite of this apparent set-back to the hydro-electric idea, the Magazine will continue to press its advocacy of the utilization of the water-power resources of the country. Hydro-electric power does not consume the reserves of fuel, is independent of the squeezings in the coal and oil markets, and does not foul the atmosphere by the discharge of smoke and noxious gases.

The Flotation Process.

Following on the paper by Mr. H. L. Sulman on the theory of flotation, read at the November meeting of the Institution of Mining and Metallurgy, came another paper, on the application of flotation methods, by Mr. Walter Broadbridge, read at the January meeting. Mr. Broadbridge is chief engineer to Minerals Separation, and his paper dealt with the engineering and metallurgical problems involved in carrying the principle into effect. It is divided into five sections, discussing respectively the evolution of apparatus for agitation and aeration, the reagents and frothing agents, the mechanical contrivances in working the process, modifications in methods of comminution of ore, and the process's influence in altering smelting methods. The paper occupies 58 pages of the Institution's *Bulletin*, and any attempt at giving a précis or characteristic quotations in the pages of the Magazine would be futile, especially as the paper has been widely distributed in the January *Bulletin* and extra copies are obtainable by application to the Institution. We would take this opportunity of drawing the attention of our readers to the voluminous appendix to Mr. Sulman's paper, which forms part of the January *Bulletin*. These contributions to the discussions and the author's reply should be read in conjunction with the two papers themselves.

Several points arising during the reading of the papers and in the course of discussion are of special interest. In the first place, Professor Edser, the company's physicist, demonstrated the flotability of cassiterite. By means of a solution of common soap he raised black tin to the surface. Secondly, it has been announced that the company is now applying the process to the recovery of fine coal from the slurry which leaves the coal-washers. It is well known that in these coal-washers large amounts of fine material pass away with the water. This material consists of both coal and mineral matter. Some of it is too fine to settle readily, and is carried into the streams, and the remainder is placed on dumps or in slime ponds. It has been found that with a particular adaptation of the flotation principle an almost perfect separation is effected, and not only is the coal saved but in addition the mineral matter is precipitated and the water thus cleared. The company has acquired a large number of these refuse heaps and is preparing to concentrate them and manufacture briquettes. The amount of coal lost to the country at present by sliming is estimated variously at from ten to twenty million tons. In these days the saving of this coal is a matter of considerable economic importance.

A third matter deserving of special attention was the announcement at the January meeting of the award of the Institution's Gold Medal to Mr. Sulman. Without any disparagement of previous recipients it may justly be said that never was the bestowal of the medal so thoroughly deserved or so popular among members of the profession in this country. For long years he has worked patiently on this concentration problem. The celebrated patent with which his name is associated, in conjunction with the names of Messrs. Picard and Ballot, has been upheld in the highest courts of England, Australia, and the United States, and the process based on it is of world-wide application. One would have thought that this record of hard and successful work would bring him universal approbation. Unfortunately in the United States the success of the process and the upholding of the patent are regarded with mixed feelings. This position is, however, one of the usual sequelæ of prolonged lawsuits bitterly contested at every step. Mr. Sulman has also been exposed to a good deal of unnecessary personal criticism. Though trivial in itself, this style of criticism, being intendedly unkind, leaves an unpleasant sting. An example of this method of controversy is the comment that in his paper Mr. Sulman omitted mention of other workers in the same field. The general feeling, however, is that his paper was not intended as a complete treatise, but that it was a record of his personal views and experience, and as such it was accepted in this country with avidity. It is legitimate, at this time of day, to presuppose some knowledge of flotation on the part of the average mining engineer. Those who want a note of what has been done in the past can consult Mr. T. J. Hoover's book, and the files of THE MINING MAGAZINE and the *Mining and Scientific Press.* But, after all, these little pinpricks serve the useful purpose of bringing hosts of sympathetic friends to his side, who will ask him, instead, to remember the applause that greeted him when he replied to the discussion at the November meeting, and again when the announcement was made of the award of the Institution's medal.

Cost of Copper Production.

Correspondents often ask for the cost of copper production in the United States. This has always been a difficult question to answer, owing partly to the variation in the meaning of cost, and partly to the disinclination of some operators to disclose details. Perhaps the best set of figures so far published, other than those that can be culled from the returns of certain individual mines, is that contained in the report of the Federal Trade Commission. These tables give collective statistics for 1918 in a series of tables. As some of the information has been contributed confidentially, no individual mine is mentioned, and only averages according to district are given. The total number of companies on which the calculations are based is 85, and the mines providing information are not only those operating in the United States but also most of those under American control in Mexico, Chile, Peru, Cuba, and Canada. We give herewith a table in which the average costs are analysed according to the items of operation. The averages are those for the great groups in Arizona, Utah-Nevada, Montana, and Michigan, and for the mines in Canada-Alaska, Mexico-Cuba-South America, and also for all companies reporting. It will be seen that the cost includes every possible expense except interest, income tax, and excess profits duty. In addition to depreciation, there are allowances for amortization of the property. The original costs of the properties, by reason of both purchase price and capital spent on development, vary widely; in particular, the figure for allowance for depletion of ore in the Montana group is much higher than the average. The mining costs at Arizona, Utah, and Nevada mines are lower than the average, owing to their containing large ore-bodies easily mined. On the other hand the mining costs in Montana and Michigan are high, because the workings are deep

COST OF COPPER PRODUCTION IN AMERICA.—CENTS PER POUND.

	Arizona and New Mexico	Utah, Nevada and California	Montana, Idaho and Washington	Michigan	Other United States	Mexico, Cuba and South America	Canada and Alaska	All Companies Reporting
Mining	5·615	4·277	10·858	10·693	6·403	5·532	6·198	6·946
Depletion of ore at cost	0·627	0·528	1·225	0·508	0·385	0·718	0·999	0·720
Purchases of ore	1·056	0·649	1·613	—	0·403	0·053	—	0·515
Transportation to reduction plant	0·648	1·731	0·436	0·748	0·656	0·491	1·903	0·837
Reduction	5·278	7·800	5·165	4·551	10·988	6·939	5·523	5·891
Transportation to refinery or seaboard	0·728	0·743	0·722	0·416	0·500	1·782	0·620	0·854
Refining	1·183	1·272	1·211	0·114	1·106	0·692	1·398	1·029
General and administrative	0·899	0·892	0·432	0·742	1·730	1·373	1·007	0·899
Selling expense	0·189	0·169	0·025	0·061	0·194	0·421	0·241	0·188
Credit for precious metals	1·048	1·260	4·162	0·211	2·455	2·353	1·626	1·712
Total Cost	15·175	16·801	17·425	17·622	19·910	15·648	16·263	16·167
Actual total cost, not taking credit for precious metals	16·223	18·061	21·687	17·833	22·365	18·001	17·889	17·879

and the lodes narrower. Smelting costs in Michigan are comparatively low, as the copper occurs in the native state. There is one feature of the table to which special reference should be made, that is, the deduction of the precious metal content from the total cost. This policy is open to question, for the presence of gold and silver in copper ores provides an increase in the profits rather than a reduction of costs. We have therefore added another line to the table giving the cost irrespective of the compensating advantage arising from the presence of precious metals. A number of other tables accompany the report. From one of these we learn that 27 companies producing 66% of the total output of copper returned their costs at between 13 and 18 cents. Two companies worked at less than 12 cents, and four, representing $9\frac{1}{4}$% of the total, at between 12 and 13 cents. Eighteen companies, representing 2% of the total output, gave their costs at over 26 cents.

REVIEW OF MINING

Introduction.—The feature of the past month has been the derangement of the international exchanges and the low value of the pound in America. The price of gold has gone up accordingly, and the premium is over 40%. Silver also continues far above normal, owing largely to the great demand from China. Gold-mining shares have shown substantial rises. The rich silver-gold ores north of Stewart, British Columbia, have attracted English capital, and the venture promises to be of unusual interest.

Transvaal.—The dividends paid for 1919 by the gold mines of the Transvaal are given in the following table. General comment on the subject was made in this column last month.

DIVIDENDS PAID BY TRANSVAAL COMPANIES.

RAND.	1918 1st half	1918 2nd half	1919 1st half	1919 2nd half
	s. d.	s. d.	s. d.	s. d.
Brakpan	4 0	2 6	2 6	3 0
City Deep	4 0	1 6	2 0	2 9
City & Suburban (£4)	1 6	—	—	—
Consolidated Langlaagte	—	1 0	1 0	1 6
Consolidated Main Reef	9	6	6	1 3
Crown Mines (10s.)	1 6	6	6	3 6
Durban Deep	6	—	—	—
Ferreira Deep	2 3	2 3	1 6	1 0
Geduld	1 0	1 3	—	*b*
Geldenhuis Deep	1 0	6	6	1 6
Glencairn	—	1 0	—	—
Government Areas	2 6	3 0	3 6	4 0
Jupiter	—	3	—	—
Knights Deep	—	—	—	9
Langlaagte Estate	1 0	1 6	1 6	1 6
Meyer & Charlton	10 0	12 0	10 0	14 0
Modderfontein (£4)	17 6	24 0	26 0	30 0
Modderfontein B	8 6	8 0	9 0	9 6
Modderfontein Deep (5s.)	9 6††	10 0††	10 0††c	3 3
New Primrose	—	—	1 0	1 0
New Unified	1 0	1 0	1 0	1 0
Nourse Mines	9	—	—	9
Robinson Deep "A" (1s.)	2 0	—	—	—
Robinson Gold (£5)	1 6	1 0	5 0*	2 6
Rose Deep	2 0	1 6	1 6	3 6
Simmer & Jack	3	—	3	6
Springs Mines	2 0*a*	2 6	—	—
Sub-Nigel	1 4	1 0	1 0	1 0
Van Ryn	1 0	1 0	1 0	1 6
Van Ryn Deep	4 6	4 6	4 6	5 0†
Village Deep	9	—	—	1 3
Village Main Reef	2 0	—	4 6‡	2 0
Witwatersrand Gold	2 0	1 0	1 0	1 0
Wolhuter	9	6	6	6
OUTSIDE RAND.				
Glynn's Lydenburg	1 6	6	6	6
Transvaal Gold Mining Estates	—	6	—	9

a Paid in West Springs shares. * Bewaarplaatsen Bonus. † Also Scrip (1 New State Areas share for every 8 V.R.D. held). ‡ One Village Deep share for every four V.M.R. shares (reckoned to be equal to 4/6 per V.M.R. share). †† On old £1 shares. *b* Two "Enemy" shares for every 25 shares held. *c* Partly in Scrip.

Development at Modder East during the quarter ended December 31 gave the following results: No. 1 section, 1,185 ft. on reef averaged 13·9 dwt. over 26 in.; No. 2, 820 ft. averaged 13·9 dwt. over 29 in.; No. 3, 690 ft. averaged 14·6 dwt. over 23 in. These footages represent the percentages of payability of 50·9, 81·2, and 62·2 respectively compared with the total development. Milling is to be started with the Apex plant early in April.

It is rumoured that the directors of Modderfontein B have decided to sink a second deep shaft, taking advantage of the gold premium for the purpose of providing the necessary capital. No official statement has yet been made on the subject.

A serious fall of rock, due to an earth tremor, has occurred at the City & Suburban mine, in the main incline shaft between the 31st and 32nd levels. Mining will be confined for a few weeks to the levels above the 30th.

We recently recorded that the Albu group had decided to reopen the silver-lead mines in the Pretoria district. A prospectus has since been issued, giving details of the scheme. The new company is called the Transvaal Silver & Base Metals, Ltd., and has a capital of £70,000, of which half has been offered for subscription and readily absorbed. The old workings are to be opened and prospected, and other deposits examined. At first it is intended to ship the concentrates to Europe, but a scheme is also in hand for erecting a smelting works and refinery on the spot.

Diamonds.—Arrangements have been made for the introduction of diamond-mine shares in New York. Lazard Freres are now offering 80,000 American certificates secured by the deposit with trustees of 32,000 De Beers deferred shares. Thus every De Beers share is represented by 2½ certificates. The De Beers share has 50s. as par value and is worth £31 here at present quotations. The certificates will be issued at $47.

Details of the De Beers report are given on another page of this issue. The report of the Premier Diamond company is also to hand. This shows an income of £1,961,259 from the sale of diamonds and a working cost of £654,532. The net profit was £1,210,980, of which the Government takes £726,588, while £432,500 has been distributed among shareholders, £92,500 going to the preference shares and £340,000 to the ordinary shares, the rate of dividend on the latter being 850%. The yield per load was 0·18 carat, and the number of loads washed was 4,529,261. The reserve above the lowest workings is estimated at 32,500,000 loads.

Cable messages referring to a rush to diamond ground at Tlaring, near Taungs, in Bechuanaland, have been received in this country, but no specific details are to hand so far.

Rhodesia.—The output of gold during December is reported at £158,835, as compared with £186,462 in November, and £192,870 in December, 1918. The output was considerably below normal owing to the strike at the Gold Fields group, the figures for Falcon, Gaika, and Shamva being reduced by half. The output for the year was £2,499,498, as compared with £2,652,250 in 1918, £3,495,391 in 1917, and £3,895,311 in 1916.

The following dividends have been paid by producing companies in Rhodesia during 1919:

	Rate. %	Amount. £
Eldorado Banket Gold	7½	22,500
Gaika Gold	3	8,205
Giant Mines	3·57	9,360
Globe and Phœnix Gold	56·64	113,283
Lonely Reef Gold	45	121,953
Rezende Mines	50	60,000
Rhodesia Chrome Mines	10	6,000
Rhodesia Metals Syndicate	*	3,533
Rhodesian and General Asbestos	10	40,000
Shamva Mines	27½	165,000
Wankie Colliery	5	28,367
		£578,201

*5% on ordinary shares and 25¼% on "A" shares.

The Rhodesia Broken Hill company reports that the main shaft has been sunk to 58 ft., and that the ground below has been injected with cement to a depth of 170 ft. It is expected that sinking will be resumed this month to 150 ft., from which point a cross-cut will be driven to the ore-body.

The Gold Fields Rhodesian Development Co. has purchased a half share in the Standard Arsenic (Rhodesia), Ltd., and has floated a new company called the Standard Arsenic (South Africa), Ltd. The activities of the company are being considerably widened. Mr. W. B. Blyth will take charge of the works to be erected within the Union.

West Africa.—The Ashanti Goldfields Corporation announces that it has not exercised its option on the Winnebah lode-tin deposits.

Nigeria.—A sensation has been caused by the offer of Lever Brothers, the Sunlight soap firm, to purchase at least 75% of the ordinary shares of the Niger Company at £6. 10s. per £1 share. The £1 shares at the time of the offer stood at £4. 10s. each. The object of the deal is to secure for Levers a supply of vegetable oils produced in Nigeria, employed in the manufacture of soap and margarine. No alteration will be made in the organization of the Niger Company, so that its tin-mining operations will continue without interference.

Australasia.—We print an abstract of a report by Mr. W. H. Cundy on the Marshall theory and the evidence on which it is founded. This theory provides hopeful encouragement for exploration both north and south of Broken Hill, and the chief problem is to determine the most likely places to find rich ore-shoots reasonably near the surface. In the Magazine for September last considerable space was devoted to a discussion of this theory, and it is not necessary to go over the ground again on this occasion. The interest in Mr. Cundy's report as quoted on page 115 suffers from the absence of a locality map marked with the claims and workings. It is probable that readers outside Australia will have to wait until the publication of Mr. E. C. Andrews' report for the Geological Survey before obtaining a completely intelligible account of the structure of the extensions of the Broken Hill line of lode. In the meantime it is of interest to record that the Round Hill, White Leads, and other properties may make their appearance in the London market under the ægis of men of experience in Broken Hill affairs whenever the Australian metal position permits.

Mr. A. Montgomery, the West Australian State Mining Engineer, has been inspecting the Yampi iron ore deposit, and reports the existence of 97,000,000 tons of high-grade ore. Brief particulars of this deposit, on Yampi Island, off the north-west coast, were given in the December issue, page 372.

The Government of Victoria has decided to go ahead with the plan for developing the Morwell brown coal deposits, and is about to issue a loan of £3,000,000 in order to raise the necessary working capital. The coal will be gasified, and the first section of the electric plant will have a capacity of 50,000 kilowatts.

India.—The output of gold in India during 1919 was 461,171 oz., as compared with 485,236 oz., 520,362 oz., 541,077 oz., and 556,596 oz. in preceding years, these figures showing a gradual steady shrinkage. The Government has decided to revert to the old standard of 10 rupees per £1 gold, instead of 15 as was fixed when gold was made legal tender.

After thirty years of wonderful prosperity the Champion Reef gold mine at Kolar has dropped out of the list of dividend payers. Details of the position are given in the section "Company Reports" elsewhere in this issue. The directors and managers confidently hope that increased development will restore the fortunes of the enterprise. This incident, following so soon after the issue of new capital by the Mysore company, serves to remind us that the Kolar mines have arrived at old age. To vary the proverbial simile, even St. Simon and Galopin did not live longer than thirty years.

Malaya.—The Ipoh Tin Dredging Co. has acquired from the Borneo Company some tin-dredging land at Kamunting. The capital is to be increased from £90,000 to £225,000 by the creation of 135,000 new shares of £1 each. Of these shares, 20,800 are to be issued to the Borneo Company as purchase price, and 89,600 are being offered to shareholders for subscription at par, in order to provide funds for two dredges, the remainder of the shares being held for issue at some future time.

The Kampong Kamunting Tin Dredging Co., of Sydney, announces that its subsidiary, the Asam Kumbang Tin Dredging Co., has at last got to work, after several years delay owing to the difficulty of obtaining steel for the construction of its dredge. This dredge is said to be the largest ever built for treating tin ground.

In November we mentioned that the Pengkalen company, one of the Wickett group, with headquarters at Redruth, had acquired an additional tin property in Perak. In order to provide a dredge to treat this ground, further capital to the extent of £100,000 is to be created, and 80,000 shares of £1 each are to be offered for subscription to present shareholders.

Siam.—The Siamese Tin Syndicate has floated a subsidiary company, called the Bangrin Tin Dredging Co., to acquire an alluvial tin property about five miles north of the Syndicate's property at Ngow, in the province of Renong, Western Siamese States. Boring has proved the existence of 16,000,000 cu. yd. of ground averaging over $\frac{3}{4}$ lb. per yard. The ground is eminently suited for treatment by bucket-dredge. The capital of the company is £170,000, of which £10,000 in cash and £40,000 in shares goes as purchase price to the Syndicate; 115,000 shares have been offered for subscription at par, of which 105,000 shares will provide the working capital required for developing the property and erecting a dredge.

In November it was recorded that the Renong Tin Dredging Co. was examining a new property, situated in Selangor, Federated Malay States. The company now announces that the option has been exercised. Of the 1,000 acres acquired, 650 has been already proved to be suitable for dredging. The Rasa property covers 550 acres and the Kuala Kubu 100 acres. The former contains $1\frac{1}{8}$ lb. of tin oxide per yard over a depth of 24 ft., and the latter $1\frac{2}{3}$ lb. per yard over 18 ft. The purchase consideration is 32,000 shares. The capital of the company is to be increased from £125,000 to £200,000, in order to pay for the property, and, later, to provide funds for building a new dredge.

Cornwall.—In the last issue of the Magazine, our Camborne correspondent referred to the fact that Minerals Separation had not proved the applicability of the flotation process to Cornish ores, and instanced the Killham and Carnon plants as examples of installations that had failed. Mr. Walter Broadbridge, chief engineer to the company, tells us that the failure of these plants had no bearing on the question of the value of the process. He shut down the Killham plant because the ore was far too poor and patchy for continuous running on even grade. As regards the Carnon scheme, this was abandoned before any plant was provided. We take this opportunity of removing a wrong impression which seems to have been prevalent in Cornwall.

Last month our Camborne correspondent gave some particulars of the deal whereby the Geevor company undertook to provide funds to continue operations at Levant. The new company to acquire Levant has now been formed, with a capital of £160,000 in 10s. shares, of which £60,000 will be cash working capital. Shareholders in the Geevor company are being offered 90,000 shares at par, in the proportion of one share for every four Geevor shares held. A new shaft is to be sunk, and a modern mill is to be provided.

British Mines.—A company called the Union Mining & Smelting Co. has been formed with a capital of £500,000, the whole of the shares being offered to the public. This is quite in the nature of a blank-cheque business, for no property is specified, though the directors say that special attention will be given to the "rich mineral deposits known to exist in North Wales." The company comes from the same stable as English Oilfields, Ltd., which is exploiting the Norfolk oil-shales. For ourselves we should want to know more of the technical ability of the controllers behind the scenes before attempting to gauge the prospects of the scheme.

English Oil.—According to Mr. A. C. Veatch, geologist to the Pearson group, operations at the Hardstoft and other Derbyshire wells have ceased because the question of the ownership of the oil has become acute, now that the war emergency is over, and a lawsuit is expected.

The English Oilfields, which is developing the Norfolk shales, is causing considerable anxiety among oil engineers and geologists owing to the issue of only brief press statements calling attention to particularly favourable results of bores. Moreover, the speeches at the shareholders' meetings, though lengthy, convey little practical information. What is wanted now is a report on the whole enterprise by an oil engineer of recognized standing. It is of course known that oil shales exist there; some reliable information as to the average oil content of the shales, as shown by the bores, and the ability of the chemists to reduce the sulphur content to an acceptable limit at reasonable cost, should be published without further delay.

Canada.—In December we gave information relating to rich silver-gold deposits north of Stewart, British Columbia. It is now announced that English capital is to be put into the development of some of these properties. The company interested is the Selukwe Gold Mining & Finance Co., and a company called the British Canadian Silver Corporation is to be formed. The management will be in the hands of Mr. C. A. Banks. These great silver sulphide lodes have the promise of being the most important ore deposits discovered during the last few years.

Siberia.—The collapse of the opposition to Bolshevism appears to have been complete, and the Red power has arrived as far as Vladivostok.

The reorganization of the Urquhart group of companies as the Russo-Asiatic Consolidated has been hindered to some extent by the demand of the Revenue authorities from the liquidator of the Russo-Asiatic Corporation for the payment of £147,500 for excess profits duty for the year commencing June 30, 1914. In order to prevent delay, the liquidator has asked shareholders to deposit 10s. per share with him in applying for the proportion of Russo-Asiatic Consolidated to which they are entitled under the reorganization. In this way the liquidator will have funds to meet the tax, but he hopes that an appeal will result in reducing or even entirely avoiding such payment.

Norway.—The molybdenite mines of Norway have been amalgamated, and a company has been formed to work them and market the concentrates, called the Norske Molybdenproducter A.S., with offices in Christiania. It is intended eventually to start works to produce ferro-molybdenum and molybdenum compounds. The present output of concentrates is equal to about 200 tons of MoS_2 per year. Most of the mines are in the south of Norway, and were described by Mr. E. R. Woakes in a paper quoted in the Magazine for February, 1918. We are informed that important deposits of molybdenite have been developed in the northern part of Norway during the last two or three years.

Colombia.—As recorded last month, the British Platinum & Gold Corporation is to absorb the property of the Paris (Transvaal) Gold Mines, these two companies owning jointly alluvial ground in the Choco district. To effect the amalgamation the capital of the first-named company has been increased, and 162,509 shares have been allotted to the latter company. The directors announce the issue of 187,491 shares of £1 at 25s. each for subscription among shareholders in the two companies. This issue had been underwritten, so that the company is assured of the necessary working capital for the expansion of operations. The total share capital issued will now be £600,000.

Peru.—The activities of the Peru Syndicate, formed last year, are being expanded and further capital has been subscribed. Last month 100,000 shares of 5s. each were offered to the public at 15s. per share, and the whole have been taken up. Dr. T. R. Marshall, M.Inst.M.M., is on the board, and is consulting geologist and mining engineer to the company. The options held by the syndicate are extensive. The properties to which these options relate include oil lands in three parts of Peru, potash deposits, copper, silver, silver-lead, and gold mines. The company also has options on oil lands in Trinidad. The prospectus does not give much information about the properties. The capital now raised is to be devoted to the testing of the oil lands under option.

Venezuela.—The recently formed National Mining Corporation has taken an interest in the South American Copper Syndicate and Mr. J. A. Agnew has joined the board. This company was formed in 1907 to reopen copper deposits in the district of Aroa, which had from 1866 to 1894 been worked by the Quebrada company, one of the Matheson group. In the latter year the workings collapsed and operations were abandoned. The present company made big profits on a small capital, and under disadvantageous circumstances, between 1909 and 1917, and after that the difficulty or impossibility of marketing the produce put a stop to everything. The policy of the National Mining Corporation is to undertake a comprehensive scheme of exploration by drilling. Additional shares are now being issued, and a larger plan of financial reorganization will be recommended in the near future.

THE HEMERDON WOLFRAM-TIN MINE

By ERNEST TERRELL, M.Inst.M.M.

The author gives an account of a wolfram deposit on the southern fringe of Dartmoor that was developed during the war for the purpose of increasing the supply of tungsten required for manufacture of high-speed tool steel.

THE Hemerdon mine is situated on the southern fringe of Dartmoor and about seven miles from Plymouth. Its position is shown in the map printed on the following page. Its discovery was directly due to circumstances resulting from the outbreak of war, which found the country lamentably short of tungsten. The Ministry of Munitions sent representatives to Devon and Cornwall to stimulate the production from known sources of supply and to induce the search for new deposits. The first discovery at Hemerdon was a lode averaging 26 in. wide on the outcrop, which was followed through a quarry for a distance of 150 ft., and contained 0·97% WO_3. The lode was afterwards traced farther westward, showing increased width and values in that direction. Its position is indicated at the extreme south on the plan and section, Figs. 3 and 4, pages 78, 79. Attempts to locate the lode eastward through the small plantation marked "Hemerdon Ball" were unsuccessful, and the search terminated with the excavation of a long trench immediately east of the Ball. Although the trench failed to reveal the lode it was observed that the excavated material contained innumerable small veins of quartz, practically all of which were wolfram-bearing. In the quarry the enclosing rock is fairly hard granite, but in the trench the ground was found to be soft and decomposed, pertaining to the nature of china-clay deposits.

The prospectors suspected they had struck a stockwork deposit, and a few more pits were sunk in the decomposing igneous ground. The results confirmed the opinions entertained, each pit exposing a network of small veins containing good wolfram values. The writer

FIG. 1. GENERAL VIEW OF MILL, POWER-HOUSE, AND WORKSHOPS.

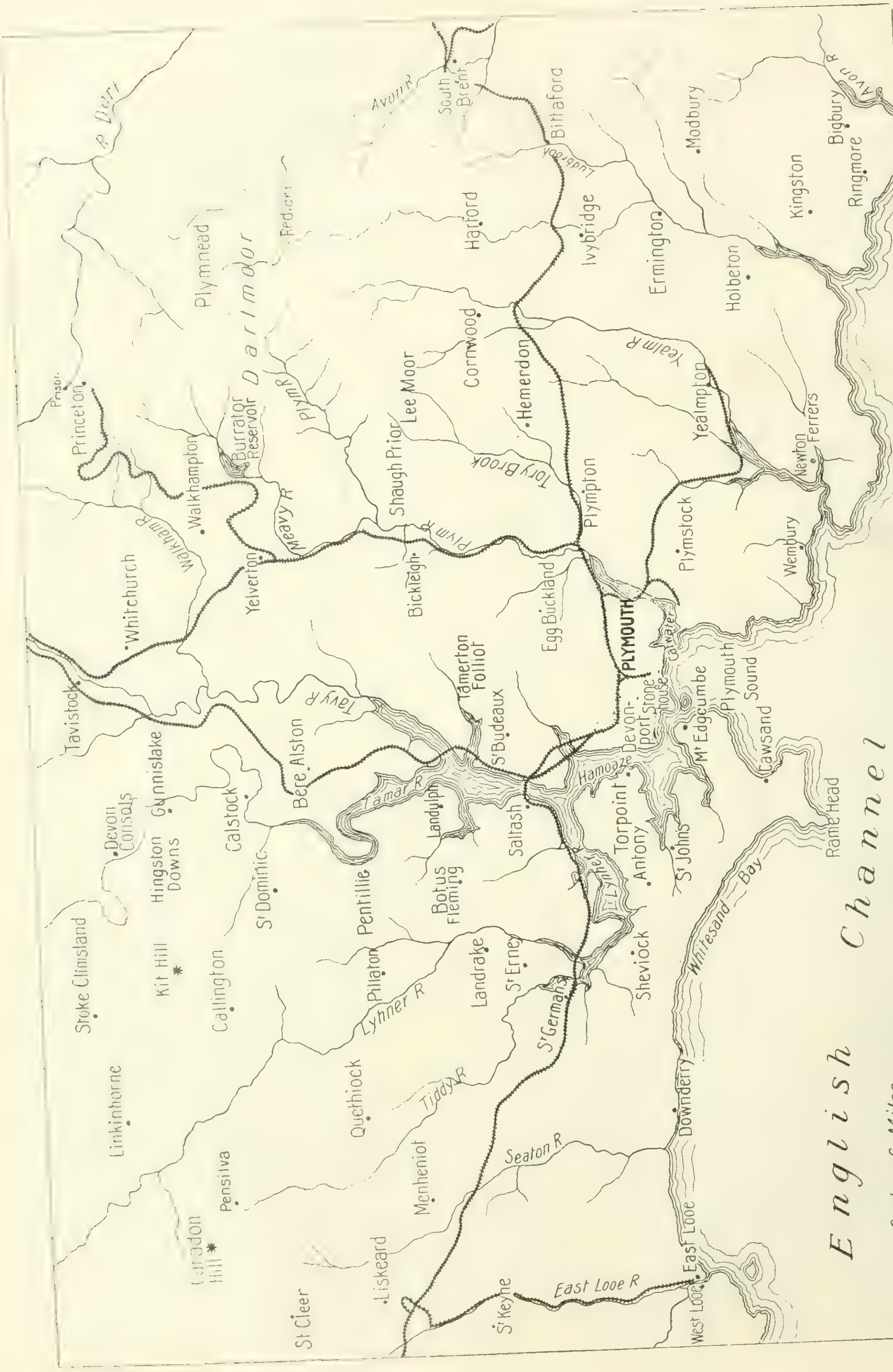


FIG. 2. MAP OF SOUTH-WEST DEVON AND SOUTH-EAST CORNWALL, SHOWING POSITION OF HEMERDON.

first became acquainted with the property at this stage, and an examination indicated the probable extension of the stockwork formation for a considerable distance. The western margin of the igneous ground was soon found, and although the quartz veins continue for a short distance in the metamorphic aureole of the adjoining Upper Devonian slate, only very occasional specimens of wolfram were obtained from pits sunk in the latter material, although this ground in bulk was found to contain 2 to 3 lb. of cassiterite per ton. It therefore appeared probable that tungsten and tin in commercially profitable values were confined to the igneous area. The prospectors continued pit sinking, all their pits being indicated in the plan, Fig. 3, by small crosses. The greatest depth they reached was 44 ft., in the pit marked "Shaft," and the longest continuous pit was the one marked "Long Trench," this excavation being 70 ft. in length by 4 ft. wide by 15 ft. deep. The other pits were 6 ft. by 3 ft. in area, and of depth varying from 9 ft. to 12 ft. The mineral contents of the material excavated from the pits averaged 10 lb. of wolfram and cassiterite per ton, and this included the overburden, which varied between 3 ft. and 6 ft. in depth and contained only 2 to 3 lb. of wolfram and cassiterite per ton. The results indicated above were considered to warrant extended tests which, if confirmatory, would justify exploitation on a commercial scale. An option on the property was secured by a company, and pits were sunk more systematically to depths of 12 ft. to 20 ft. at the points marked on the plan, Fig. 3, with short dashes. These pits more accurately defined the igneous area, which, so far as it was tested, is indicated by the shaded portion on the same plan. The mineralized ground, however, continues down over a southern slope, passing eastward of Hemerdon Ball, but it was not followed in view of the enormous volume of ore contained in the area to which attention had been confined. Further proof was also obtained that only the igneous ground was worthy of attention and that decomposition was fairly uniform over the area tested, very little blasting being necessary to the depths attained in the pits. The dissemination of wolfram throughout the prospected area is a noteworthy characteristic. The veins, which vary in thickness from a fraction of an inch to 4 ft., are so closely associated that even 1 ft. of intervening granitic material is unusual. They dip into, intersect, and occasionally cut out each other in an extraordinary manner, without faulting, but are invariably mineralized to a greater or lesser degree. Notwithstanding the network appearance of a cross-sectional view, the veins have a general bearing approximating 25°E. of N. by W. of S., with the larger ones dipping about 50° from the horizontal to the N.W., and these absorb many of the smaller ones—which generally dip at a greater angle—or are intersected by them. The photograph, Fig. 6, shows the front and side of a working stope, illustrating (at the front) the dip and (on the right hand side) the strike of the veins. The horizontal layers of alluvial overburden can also be seen.

It may be observed by reference to the plan, Fig. 3, that several pits were sunk actually on the geological contact line. The two rock systems have a perfectly defined junction, practically vertical to the shallow depth of exposure. On the same plan two tramway cuttings may be seen projected just to the western limit of the igneous intrusion. These have since been extended into the latter formation, and a study of the ground on each side of the contact line reveals no extensive metamorphic effects.

Of the material excavated from the pits sunk by the company in the igneous ground, half of the total quantity, amounting to 109 tons, and exclusive of alluvial overburden, was taken for a bulk test and treated through the crushing and concentration plant of another mine in Devonshire. The results obtained were as follows:

Battery Pulp Sample:	0·8% WO_3 and Sn by chemical assay.
do. do. do.	0·62% wolfram and black tin by vanning assay, the vanned concentrate assaying 68·4% WO_3 and Sn.
Battery Pulp Tailing:	0·18% wolfram and black tin by vanning assay.
Actual Final Recovery of Clean Concentrate:	0·532% of wolfram and black tin, equivalent to 11·917 lb. per ton of 2,240 lb.

The proportion of WO_3 to Sn in the clean concentrate finally recovered was as 75·02 is to 24·98. It should be explained that the slime plant was insufficient to deal with the unusually large proportion of clay and slime in this ore, and consequently the loss of mineral in the finest sizes was rather high.

A wet screening test was also made on 9 tons of ore to ascertain the quantity of minus $\frac{1}{8}$ in. material, as it was found that the parti-

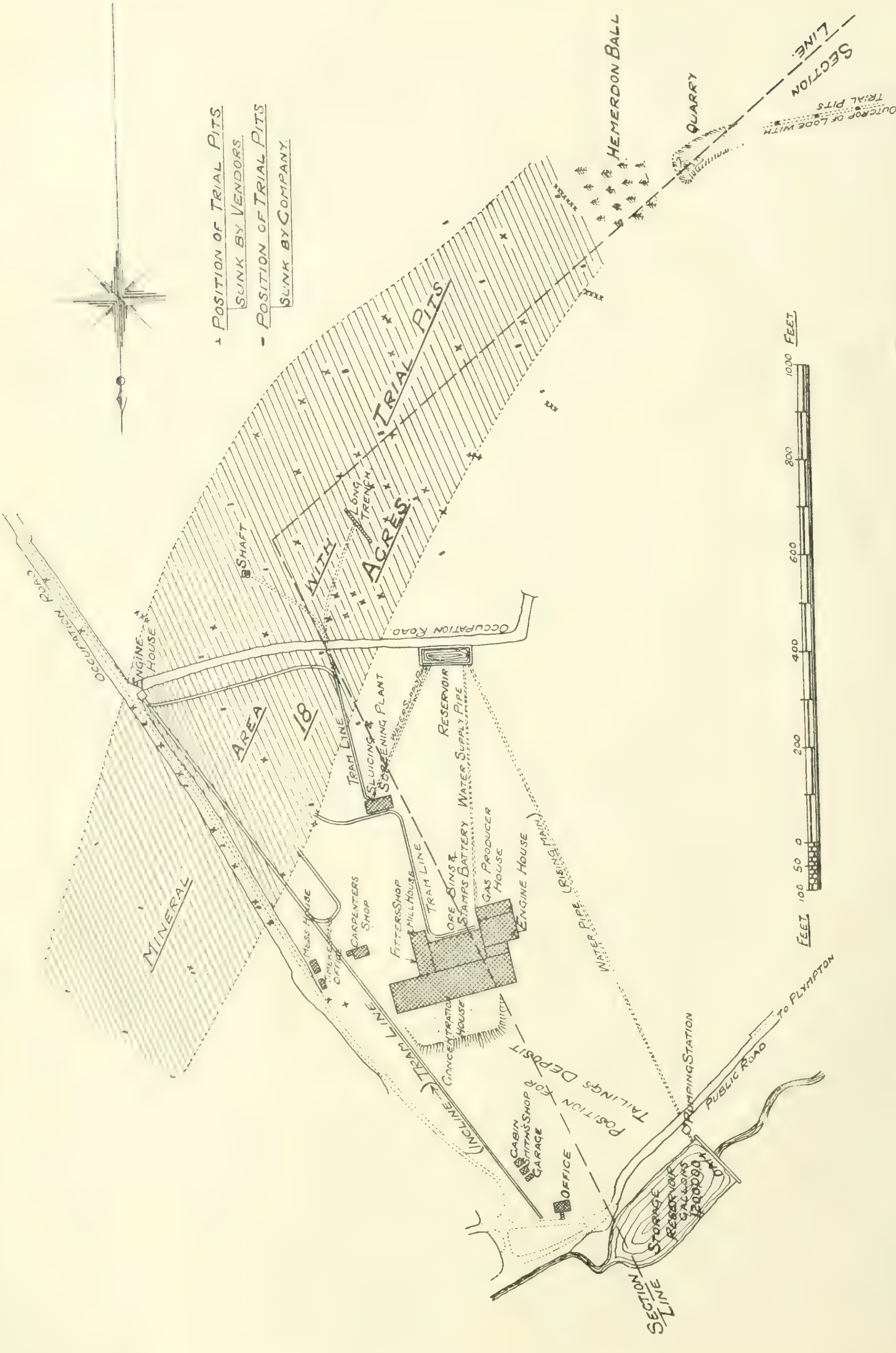


FIG. 3. PLAN OF HEMERDON PROPERTY.

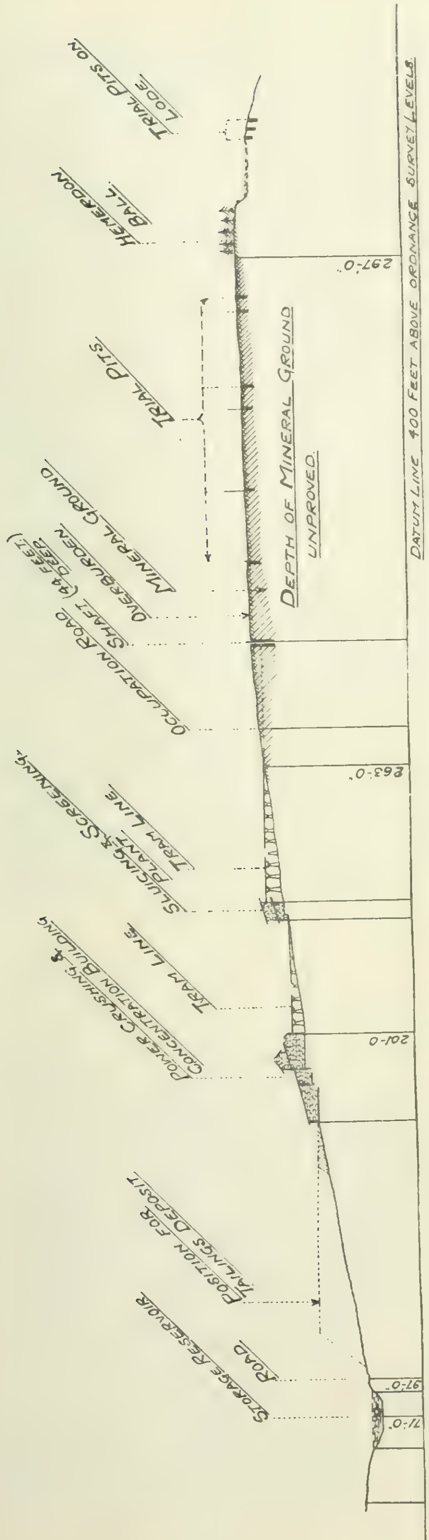


FIG. 4. LONGITUDINAL SECTION THROUGH HEMERDON PROPERTY.

cles up to this size were sufficiently free of gangue to be recoverable without further crushing. The test resulted as follows:

Plus $\frac{1}{8}$ in.	67·08
Minus $\frac{1}{8}$ in.	32·92

The results indicated by the mill assay and recovery figures may be examined with interest, especially in view of the information obtained in recent years by research work on Cornish mill and concentration practice. The battery pulp assay of 0·8% WO_3 and Sn is equivalent to 1·17% wolfram and cassiterite on the basis of 68·4% indicated by the assay of the clean vanned concentrate. We therefore have the following figures:

		%
Apparent total wolfram and cassiterite in the ore		1·17
Wolfram and cassiterite recovered	(a) by vanning assay	0·62
	(b) in actual practice	0·532

The vanning assay, which usually gives results approximating those obtained in mill practice, showed in this case a recovery of 53·0% of the apparent total mineral contents, while the actual mill recovery was only 45·47%.

Further examination of the mill pulp sample, concentrated products, and tailings afforded the following additional information. A proportion of the wolfram in the ore, sufficient to account for just half the difference between the vanning assay result and the total mineral content, was found to be in an extremely fine state, or such other form as to prohibit recovery by any of the ordinary mechanically operated slime-dressing appliances. This is undoubtedly due in the main to disassociation of the crystals, augmented by incipient solvent action, for which the character of the deposit establishes favourable conditions to shallow depths.

A portion of the slime mineral, as distinct from that last referred to, was found to be recoverable with adequate slime plant, and this brought the total recoverable mineral up to 0·64% or 14·33 lb. per ton in the respective proportions of 10·75 lb. of wolfram and 3·58 lb. of cassiterite.

The products obtained from the bulk test were further dressed by means of a Buss sand table, buddles, and kieves. A sample of the clean concentrate was passed through a Wetherill-type magnetic separator, and the following table gives the results:

	Weight in. lb.	Per Cent WO_3	Per Cent Sn.	Per Cent TiO_2
From 1st 2nd, & 3rd Magnets	0·6	9·23	1·56	0·47
Do. 4th do.	72·0	61·65	0·51	0·24
Do. 5th do.	0·4	59·95	0·69	0·36
Non-Magnetic	24·0	5·79	34·25	0·05

The extremely small proportion extracted by the first three magnets indicated the comparative freedom of the concentrate from highly magnetic oxides of iron and other minerals. An examination of the particles proved that many of them were wolfram, much decomposed, leaving a residue abnormally magnetic and consisting mainly of iron and manganese oxides. The presence of such material accounts for the high percentage of WO_3.

Nearly all the wolfram was extracted by No. 4 magnet, No. 5 recovering the small amount which passed it. The wolfram product was of a pronounced brownish colour, again suggestive of incipient decomposition, probably responsible for the rather low WO_3 content.

The non-magnetic product contained, in addition to the tin, the residual gangue, chiefly silica. It may also be observed that 5·79% of WO_3 was present. On being again passed through the separator no further extraction of magnetic mineral took place, and no wolfram could be seen in it. Scheelite was easily recognized, however, and undoubtedly accounted for the WO_3 indicated.

All the products were assayed for TiO_2, as ilmenite was known to be a troublesome constituent of some wolfram ores. The assays showed its presence, but in negligible quantities.

The results obtained from the prospecting work achieved, taken in conjunction with the estimated cost of exploiting the deposit, were deemed to be satisfactory, and the writer was instructed to prepare plans and estimates for a power and treatment plant to handle 100 tons of ore per day. The scheme was almost immediately revised and enlarged to treat 400 tons per day on urgent representation from the Government as to the serious shortage of wolfram for purposes connected with the war. This was considered justifiable in view of an understanding with the Minister of Munitions' representatives that the price of wolfram would be maintained for a post-war period of two years —an understanding, however, which has not been carried out.

The question of power was given full consideration, and eventually suction gas was decided on. An order was placed with Messrs. Tangyes, Ltd., Birmingham, for three horizontal two-cylinder gas engines, each rated at 240 b.h.p. for continuous running, together with three complementary producer plants. All the gas supply arrangements were inter-connected in order to run either engine from either producer set. The three engines were arranged to drive a main shaft, the power from each engine being transmitted by seven 2 in. diameter cotton ropes. The main shaft was fitted with three Bridge friction clutches, thus enabling either engine to be thrown in or out of com-

FIG. 5. VIEW SHOWING METHOD OF EXPLOITING THE STOCKWORK.

FIG. 6. FACE AND SIDE OF WORKING STOPE, SHOWING VEINS LONGITUDINAL AND IN CROSS SECTION.

mission without the slightest check to any of the mill plant. It was computed that two of the engines would drive all the mill and auxiliary machines, with power to spare, which could be utilized for driving additional appliances if found necessary. One engine would serve as a reserve, and each in turn could be cleaned or overhauled without involving stoppages.

In deciding on the crushing and concentration equipment several unusual features required careful consideration. A study of the occurrence of the wolfram in the stockwork veins showed a considerable proportion of it to be present in quite fine particles, and it was apparent that finer crushing than was otherwise desirable would be necessary for separation from the enclosing gangue, As indicated by the screening test referred to earlier, the ore contained quite an unusual proportion of minus $\frac{1}{8}$ in. material, the result of decomposition and disintegration of the ore-body generally, and in which both the wolfram and cassiterite were in the free state. A large percentage, however, consisted of extremely fine clay carrying no appreciable mineral values. Even after eliminating the finer sizes the remainder of the ore was so soft that a high duty was obtainable from an efficient crushing plant. The concentration question was simplified by the absence of sulphides and valueless heavy oxides. The ore being low-grade it was evident that the concentrating machines adopted should give very full duty in the matter of tonnage handled.

The general lines decided on embodied screening out the minus $\frac{1}{8}$ in. ore for treatment without crushing, passing the remainder through a Californian stamp-battery, classification of the pulp and concentration on sands, fines, and slime dressing machines, finally separating the recovered wolfram and cassiterite magnetically.

The ore-treatment system may now be described, and from the point of the stamp ore-

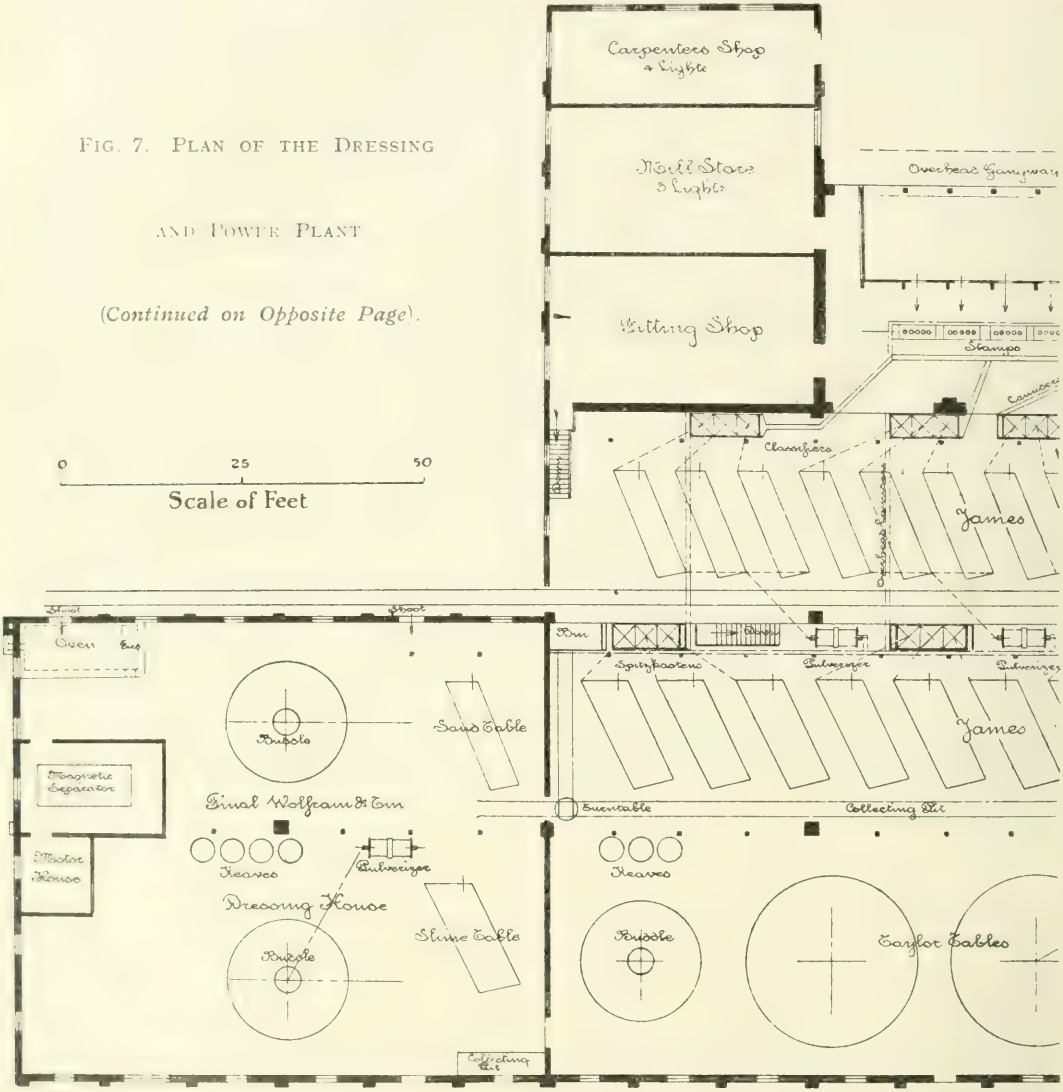
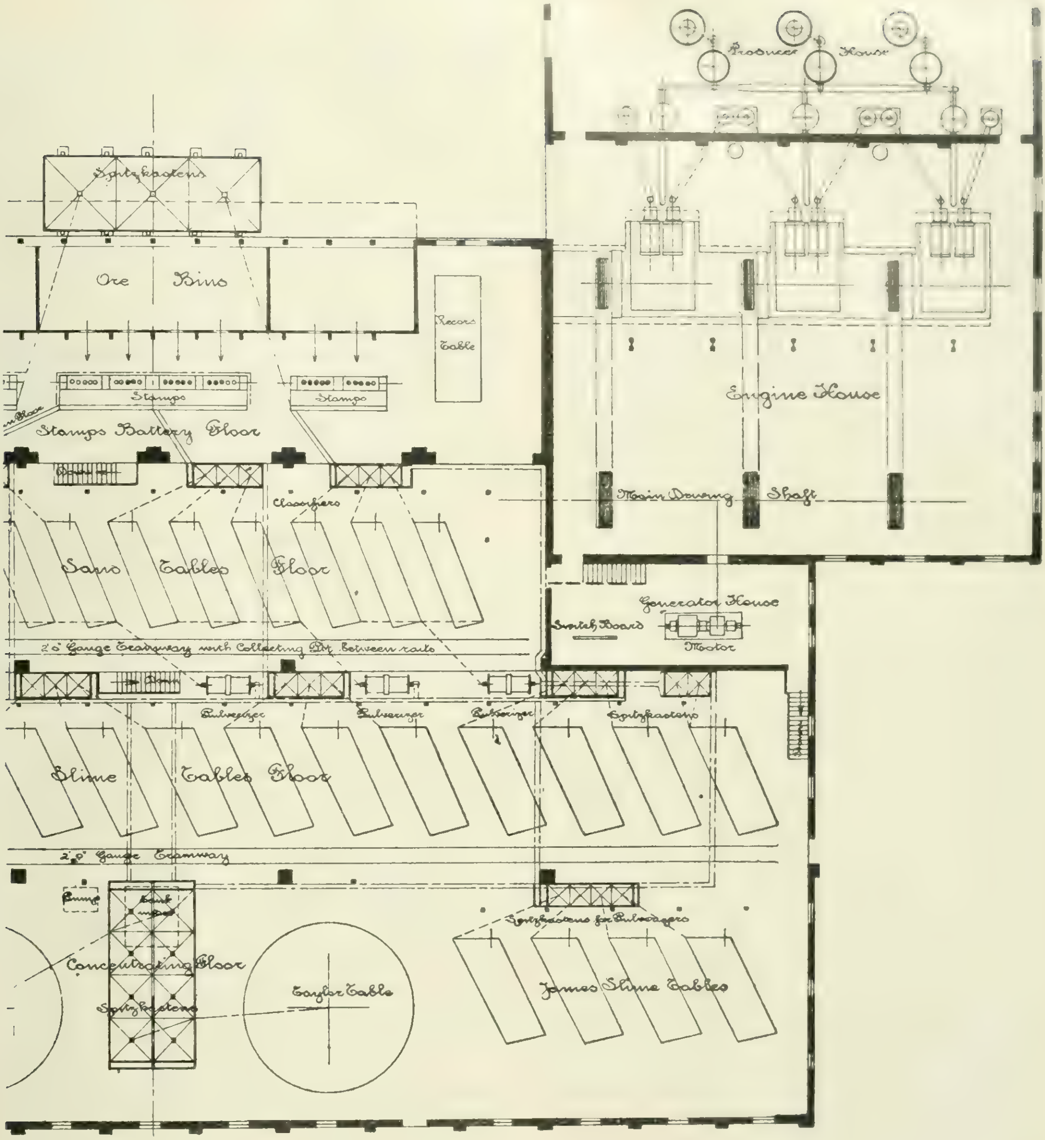


FIG. 7. PLAN OF THE DRESSING AND POWER PLANT

(*Continued on Opposite Page*).

bins can be followed by reference to the plan, Fig. 7, above and opposite. An outline cross-section is added to indicate the arrangement of the different floors. I am most grateful to Mr. B. Ewens for kindly making this reduced-scale drawing from the originals.

The stockwork is attacked by making a cutting into the hillside, and on this attaining a depth of 10 ft. enlarging it in the form of an open quarry, as shown in Fig. 5. The ore as broken is trammed over a level tramway to a bin, from which it is passed over a pair of grizzleys or bar screens, the bars being set $1\frac{3}{4}$ in. apart. The oversize material is fed into a rock-breaker and drops into a bin underneath, from which it is trammed to the stamps ore-bins. The minus $1\frac{3}{4}$ in. material from the grizzleys is met by a stream of water and washed along a sluice 30 ft. by 4 ft. wide and having a 10% inclination. This serves to wash out the clay and disintegrate much of the softer granitic material. The flow is delivered into a set of two revolving trommels, the screens of the first having $\frac{3}{8}$ in. diameter perforations, while those of the second are $\frac{1}{8}$ in. diameter. All the plus $\frac{1}{8}$ in. sizes fall into bins and are trammed to the battery ore-bins, where it joins the rock-breaker product. The minus $\frac{1}{8}$ in. ore



from the trommels flows to a large spitzkasten 30 ft. long by 10 ft. deep by 8 ft. wide at the top. A rough classification is obtained, the sands and fines being settled, while most of the clay, which is commercially valueless, is carried off in the overflow and conveyed in a launder to cement settling tanks. From these the clay is periodically washed out and deposited with the mill tailings. The overflow water from the tanks is utilized for the stamp battery and concentrating requirements.

The discharge from the bottom of the spitzkasten is classified hydraulically, the sands from the spigot being treated on the Record table shown to the right of the stamp battery on the plan, Fig. 7. Two additional Record tables are in course of erection behind the battery orebins, and will be required to cope with these sands when the whole mill is in operation. The overflow from the classifier joins the battery pulp flow.

The stamp battery consists of 50 heads of the Californian type, each of 1,050 lb. The discharge from the stamps is through steel woven screens of 10 S.W. gauge, this mesh being found to give the most all-round satisfactory results.

The pulp from each 10 heads is taken to thre hydraulic classifiers, and the spigot discharge from each classifier is fed to a separate James sand table, each table thus treating a different size of ore. The tables give three products. The concentrates vary from 75 to 90% combined wolfram and cassiterite, and are taken direct to the drying furnace in the dressing house, and dried preparatory to magnetic separation. The middlings contain partly decomposed wolfram, wolfram and cassiterite not freed from adhering particles of gangue, and oxides of iron. They are passed under the James table floor to the barrel pulverizers which can be seen by the back wall of the James slime-table floor shown in the photo, Fig. 9. The middlings are passed rapidly through the pulverizers to avoid sliming and laundered to classifiers, the spigot discharges being treated on James slime tables, while the overflow joins the general bulk of slimes for treatment as described later. The tailings from the James sand tables are run to waste.

Returning to the overflow from the classifiers taking the battery pulp it may be seen by reference to the plan, Fig. 7, that this is led to 3-compartment settlers on the James slime-table floor. The discharge from each compartment is treated on a James slime table, but even the finest discharge, from the third compartment, should be described as fines rather than slimes. Three products are obtained from the fines treatment: heads, middlings, and tailings. The heads vary from 10 to 30% wolfram and cassiterite content and are further concentrated by buddling, and still further reduced by tossing or kieving until containing 70 to 80% of wolfram and cassiterite. The concentrate is then dried for magnetic separation. The middlings from the James slime tables are treated by buddling and tossing until sufficiently rich to mix with the heads. The tailings are poor enough to run to waste.

The overflow from the settlers on the James slime-table floor, together with the overflow from the classifiers receiving the pulverized sand middlings, is taken to the pump shown near the Taylor tables and lifted 18 ft. to a large spitzkasten overhead, in which the slimes are settled and drawn off for treatment on three of Taylor's patent revolving slime frames, but only one of these tables has yet been put in commission. Two products—heads and tailings—are taken from the Taylor table. The heads are re-concentrated by treatment similar to that accorded the heads and middlings from the James slime tables, and the tailings are run to waste.

The concentrates obtained from the concentration operations described are dried in the furnace shown in the dressing house, which is on the same level as the slime-table floor. The furnace is of the flat-oven type with a fire-place at one end, the fumes being discharged through a brick chimney at the opposite end.

The concentrates are dried and magnetically separated in three classified products: (1) concentrates from the James sand tables, (2) concentrates from the buddled and tossed heads and middlings from the James slime-tables, together with those obtained from the pulverized sand middlings, and (3) the re-concentrated heads from the Taylor table. It is found in practice that although no sulphides are present the best separation results take place when the concentrates are given a slight roast at a dull red temperature.

The magnetic separator is of the improved Wetherill type, and has four electro-magnets and an off-set simple magnet for extraction of any highly magnetic minerals. An excellent separation is effected in respect of the cassiterite and the bulk of the wolfram. A small quantity of the latter mineral, amounting to from 4 to 6% of the whole is, however, very troublesome. It consists mainly of partly decomposed particles of wolfram, high in iron and low in tungsten contents, and more magnetic than the bulk of the wolfram. This is further dressed by means of buddles and James tables and thus separated from the purely iron oxides of lower gravity. Re-grinding is frequently necessary, with consequent loss of mineral, while the final concentrate obtained from it is usually only about 48 to 50% WO_3. It is intended to try the sulphuric acid process on this material, the same having given good results in laboratory tests.

The non-magnetic product from the sand concentrates is cleaned on a James sand table, and that from the fines and slimes is buddled and tossed until clean.

The following tables show the tungstic oxide and tin contents of average-quality parcels of wolfram and black tin sold.

WOLFRAM CONCENTRATE.

No.	WO_3.	Sn.
	%	%
1.	60·7	1·92
2.	60·2	1·43
3.	59·2	1·21
Average	60·03	1·52

TIN CONCENTRATE.

No.	Sn. %	WO_3 %
1.	65·71	4·83
2.	67·85	4·26
3.	66·44	5·10
Average	67·00	4·73

The rather low percentage of WO_3 in the wolfram concentrate is indicative of the effect of partial decomposition of the wolfram as already explained. The deepest face of the open workings from which the ore supply has been obtained up to the present is only 26 ft., and of the total quantity treated the overburden represented 34%. The wolfram in the overlying 6 ft. of alluvial shows greater decomposition than that in the stockwork proper. Even at 26 ft. deep there is a marked improvement in the quality of the wolfram, and with the next stope of ground I think there will be no difficulty in bringing the concentrate up to 65% WO_3.

The tin concentrate is quite equal in Sn content to the average black tin sold from Cornish mines, notwithstanding the presence of 4·83% WO_3. The concentrate, on examination, appears to be practically free of wolfram, but scheelite is present as indicated in the earlier prospecting test, and accounts for the high percentage of WO_3.

The water-supply for all purposes is obtained from the brook which can be seen in the foreground of the photograph, Fig. 1. It is pumped from a reservoir of 1,200,000 gallons capacity, formed by a concrete dam built across the valley, to a concrete reservoir of 290,000 gallons capacity on the top of the hill above the mill buildings. A Boving turbine pump of 700 g.p.m. capacity is used, being driven by a 80 h.p. motor, 500 volt D.C. circuit. The current is generated by a 150 h.p. dynamo, driven by a large belt pulley on the engine-room main shaft.

The power station and mill house, mineral dressing department, carpenters' and fitters' workshops, and store form one compact set of buildings. It was intended to construct these of wood framing, covered with corrugated galvanized iron sheets. The construction being undertaken during the war the Government could not give permits for the use of galvanized iron sheets, and it was decided to adopt brick walls and use asbestos cement sheets for the roofs. A permit for the latter material was also refused, however. Eventually the roofs were constructed of $\frac{3}{4}$ in. match-boarding, covered with ruberoid felt, and supported by lattice girders of pitch-pine resting on brickwork pillars. The buildings are lit throughout by electricity. The form of construction can be seen by reference to the cross-section in Fig. 8 and the photo, Fig. 9.

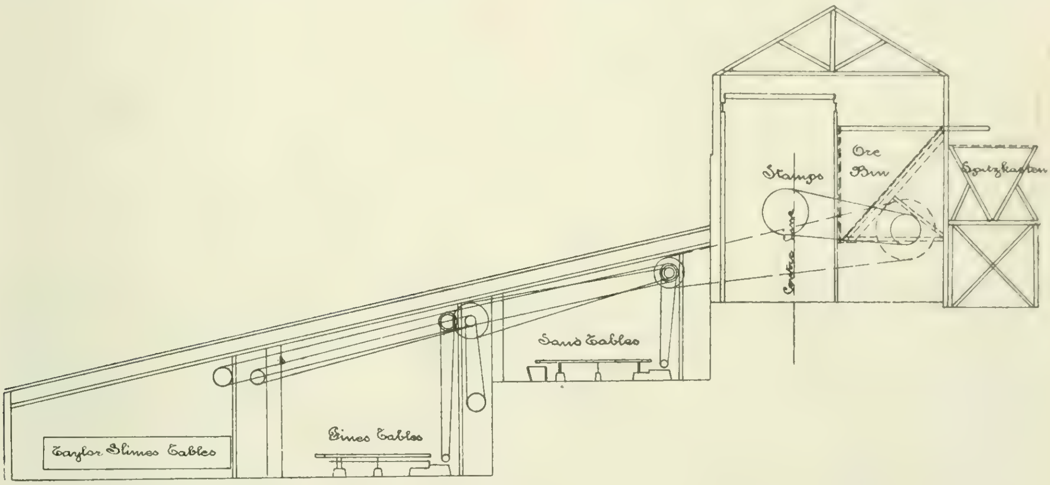


FIG. 8. VERTICAL SECTION ACROSS DRESSING HOUSE.

Fig. 1 is a photo of the mill and other buildings. An examination of this photograph in conjunction with the plan, Fig. 3, will give an idea of the general trend of the ore deposit and situation of the mill in relation thereto.

Excavation work for the buildings was commenced on July 5, 1917, and by the end of February, 1919, the buildings, power and mill plant were completed except for a little remaining work on the last 10 heads of stamps and the slime-dressing machines, while the third gas engine was still undelivered by the makers. The stamp battery has since been finished, and the third engine erected.

Throughout the period occupied in erecting the plant an extreme shortage of skilled and semi-skilled labour was experienced. When the first unit of the power and mill equipment was ready for service it was found impossible to obtain men capable of running it, notwithstanding offers of good remuneration and appeals to the Ministry of Munitions and the Labour Exchanges. Not even one experienced gas-engine driver could be secured, although three were required for continuous running. The same remark applies to the stamp battery. General labourers were therefore requisitioned for service in the engine room and stamp mill, and girls proved the only class of labour available for the concentration plant. The results obtained under these circumstances were far from satisfactory, and with the full equipment nearing completion without any indication of an improvement in the labour position, the directors felt unjustified in continuing to expose such a costly plant to the constant risk of serious accident, beyond proving the value of the mineral deposit.

Furthermore, in March, 1919, the Ministry of Munitions intimated that no wolfram parcels would be accepted by the Government after April 30. This was disappointing in view of the encouragement that department bestowed on the enterprise and the promises given of a maintenance of the war-time price for a post-war period of two years. At the same time it was stated that the existing stocks of wolfram concentrate were considerable, and producers were advised to curtail or, if possible, suspend production "in their own interests" until such stocks were reduced.

It was decided that, under the circumstances, no other course was open but to cease work, except to erect the third gas engine and complete the mill plant, and then await the return of more favourable conditions. Milling was therefore suspended forthwith.

It is unfortunate that a suspension of operations became necessary before it was possible to obtain figures indicating the actual working costs. As already stated, neither the power plant nor the stamp battery and concentrating equipment was then completed, and even the machinery in commission had not run its full trials necessary for the most advantageous adjustments to meet various conditions which only became evident in actual practice. Generally speaking, however, after allowing for an increase in the cost of labour and materials beyond the earlier anticipations, the experience gained indicates that the essential factors in connection with the proposition were recognized in advance and estimated for with approximate accuracy. The clay in the ore gives considerable trouble if even a small proportion of it is permitted to pass the washing and screening plant and find its way into the ore-bin, the tendency being to cement the ore and prevent regular feeding of the battery. On this account it may be necessary to supplement the washing arrangements, but otherwise no abnormal difficulties of treatment are encountered.

The cost of breaking the ore and tramming it an average distance of about 180 yards to the screening and rock-breaking plant is found to be 2s. 2d. per ton. The prospecting tunnel now being driven shows no perceptible increase in hardness of the ground to an additional 50 ft. of depth, and this is the principal factor likely to affect the above charge. Screening and rock-breaking cost 4¼d. per ton, exclusive of a continuous electric power supply of 16 to 18 h.p. Tramming from the screen plant to the battery ore-bin costs 5¾d. per ton, but as 28% of the ore is eliminated by the screens and washed down to the dressing plant this charge, spread over the total quantity of ore treated, is reduced to 4·14d. per ton. The total cost of breaking, screening, and delivering the ore to the stamp-mill is therefore 2s. 10·39d. plus about 1d. for power, per ton.

In the stamp-mill and concentration house the costs will certainly compare most favourably with those obtaining in West Country mining generally. The stamps give a duty of 6 tons per head per 24 hours, and as for each 6 tons passed through the stamp-mill fully two tons are delivered through the screens, the full through-put capacity, in terms of 50 stamps, is 400 tons per 24 hours.

From the experience gained in operating a section of the plant it has been found that at the stamp-battery, for the full through-put and for each shift of eight hours, two men will be required in the ore-bins and three for the ore-feeders to ensure regular feeding, but this cost may be reduced and probably eliminated altogether with cleaner washing of the ore. One stamp-man can attend to 25 stamps.

The following employees will be required on each shift with the full concentration plant in commission:

1 Foreman.
1 man attending 15 James tables treating sands from battery pulp.

1 man attending 15 James tables treating fines from battery pulp.
1 do. do. 5 pulverizers and 5 James tables treating product from pulverizers.
1 do. do. 3 Taylor tables treating slimes.
1 man cleaning out concentrates and attending Record tables treating screens ore.
3 men re-concentrating fines and slimes heads in two shifts.

In the dressing house, in which work was carried on in one day-shift only, the largest output treated was in the last 4 weeks of operations, when 13 tons of wolfram and black tin were obtained from an average of 16·35 stamps working full time. One foreman dresser, 1 man, and 3 lads dealt with the concentrates yielding this mineral, performing all the work entailed in drying, magnetically separating, and dressing the material handled. As it will be necessary to work continuously in the dressing house in 3 shifts when the entire stamp-mill is in commission, it can be taken that 12 persons will be required in this department.

Two fitters, one smith, and a carpenter are also necessary for general work in these trades.

A total of 61 can therefore deal with a through-put of 400 tons per day, from delivery of the ore at the bins to the recovery of the finished products.

It is established that, working on a full scale, the over-all operating charges, including local management, cannot exceed 8s. per ton of ore at the present cost of labour and materials.

The opportunity may later present itself for supplementing this article by giving a close analysis of working costs under the stated conditions. In the meantime it is hoped that the wolfram-mining industry will soon emerge from the dark cloud overshadowing it owing to foreign over-production, stimulated by the necessities of war, and consequent extraordinarily high prices. It is in the national interest to foster this industry by all reasonable means and not permit it to decay because of the existing abnormal conditions. Given a reasonable price and a market for the reception of its products, Hemerdon could quickly establish itself among the leading mines of the West of England.

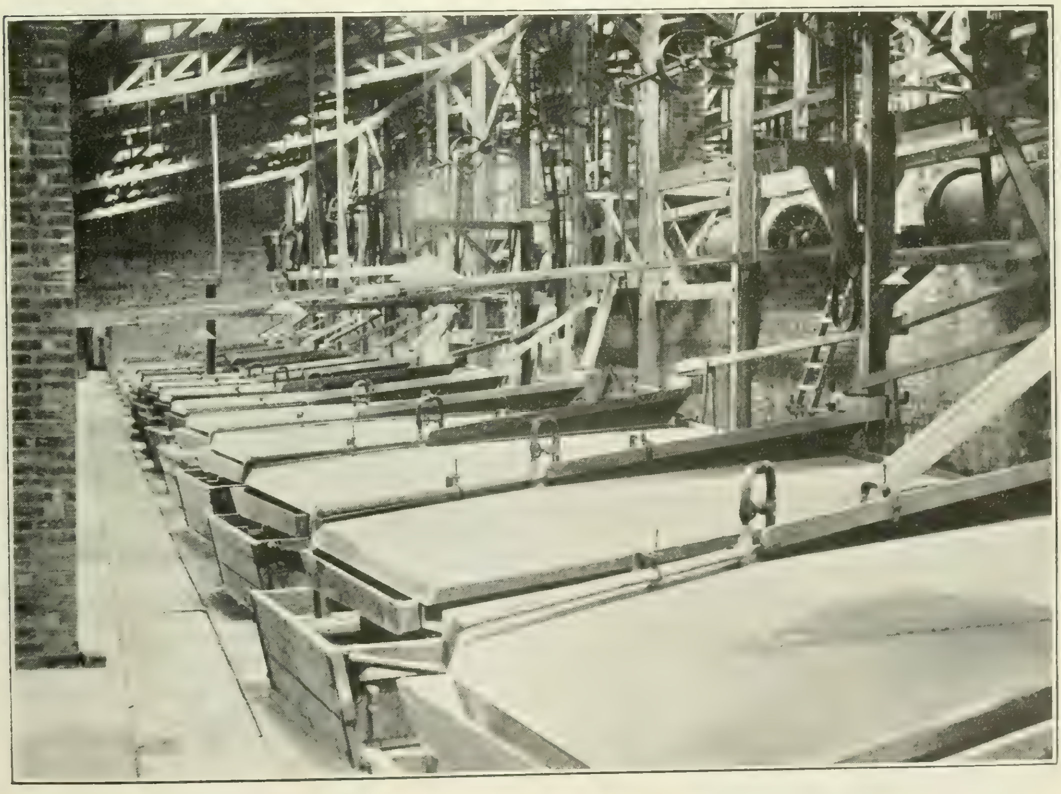


FIG. 9. JAMES SLIME TABLES AND SAND-MIDDLINGS PULVERIZERS.

THE ANALYSIS OF ALUMINIUM,

ITS COMPOUNDS, AND ALLOYS.

By J. E. CLENNELL, B.Sc., Assoc.Inst.M.M.

CHAPTER I.

MATERIALS ANALYSED AND GENERAL SURVEY OF METHODS OF ANALYSIS.

Materials for Analysis.

The materials in which aluminium may have to be estimated include alloys, ores, dust, salts, and solutions.

Alloys include sheet metal, foil, wire, and other forms, ranging from nearly pure aluminium to products containing 1% or less.

Ores include those, such as bauxite and cryolite, in which aluminium forms the major constituent, and also those in which it may be present only in small percentage, involving separation from a large quantity of other constituents.

Dust may range from coarse flakes or granules to products passing a 200 mesh screen, but we shall here consider only such material as contains aluminium as a major constituent.

Salts, such as the various alums and commercial products like aluminium sulphate sometimes require analysis or valuation for particular purposes.

Solutions include natural waters, cyanide liquors, and others resulting from metallurgical operations.

Synopsis of Analytical Methods.

The methods of analysis may be classified as gravimetric, volumetric, and gasometric. The first is of general application, but some of the volumetric methods are only applicable in particular cases, and the gasometric methods only apply to alloys or dust.

Gravimetric methods are classified thus:

(1) Determination as oxide, Al_2O_3.

(2) Determination as phosphate, $AlPO_4$.

Volumetric methods are classified thus:

(1) Titration of acid salts by phosphate solution.

(2) Titration of alkali salts (aluminates) by standard caustic alkali.

(3) Titration of neutral salts by mixed iodide-iodate solution.

(4) Determination of reducing power by means of ferric sulphate.

(5) Determination of reducing power by means of cupric sulphate.

The last two methods are applicable only to dust.

Gasometric methods are classified thus:

(1) By evolution of hydrogen from acids.

(2) By evolution of hydrogen from caustic alkalis.

Precipitation Tests.

Special tests to determine the precipitating power of aluminium dust for gold and silver in cyanide solutions.

Solvents.

In alloys or metallic mixtures such as aluminium dust, the metal is generally readily soluble in hydrochloric acid. In some cases the addition of a little nitric acid is necessary.

Ores generally require very fine grinding, and fusion of the ground sample with caustic alkalis, alkali carbonates, or bisulphates, in order to render the aluminium completely soluble in acids.

Precipitants.

Most salts of aluminium readily yield a precipitate of hydroxide, since they are hydrolysed according to the general reaction:

$$AlR_3 + 3H_2O \rightleftarrows Al(OH)_3 + 3HR.$$

R being a negative radicle such as Cl or NO_3.

The precipitation of the hydroxide, however, is only complete in presence of a sufficient quantity of some reagent capable of combining with the liberated acid; otherwise the hydroxide is only partly or not at all precipitated, or else wholly or partly redissolved at a later stage. The reagents suitable for completing the reaction are:

(1) Ammonia.

(2) Sodium, potassium, or ammonium nitrite.

(3) A mixture of potassium iodide and potassium iodate.

(4) Sodium thiosulphate.

Aluminium may also be precipitated as basic carbonate by means of ammonium carbonate, this form being more easily filtered than the hydroxide; as basic acetate from neutral or nearly neutral solutions by means of sodium or ammonium acetate; as phosphate by sodium or ammonium phosphate or by microcosmic salt, in the form of a white precipitate insoluble in acetic acid.

Indirect Determination.

Since iron is precipitated by ammonia and most of the other reagents used for precipitating aluminium, the two metals are frequently determined together as oxides, and the amount of iron determined separately in another portion of the substance analysed or subsequently by further treatment of the combined oxides. The amount of alumina in the combined oxides is then found by difference, and by calculation from this, the amount of aluminium.

CHAPTER II.

GENERAL SURVEY OF METHODS OF SEPARATION OF ALUMINIUM FROM OTHER METALS.

In the ordinary course of analysis, aluminium occurs in the third group, being precipitated, usually as hydroxide Al $(OH)_3$, together with iron and, where these are present, with chromium, titanium, zirconium, and uranium. Phosphoric acid from phosphates may also be present in this precipitate.

The metals of the first two groups (Ag, Hg, Pb, Cu, Bi, Cd, As, Sb, Sn, Te, Se, Mo, and some rarer metals) are commonly removed by precipitation with H_2S or otherwise, before the addition of the special reagents for the precipitation of the third group, but this is not in all cases necessary; for example Al, etc., may be precipitated by some reagents leaving Cu and other metals in solution. When the ore or alloy has been previously evaporated with strong acids and boiled to fumes with sulphuric acid, Pb, Ba, and Sr will have been precipitated as sulphates, before the addition of the precipitant for the 3rd group.

All the metals of the fourth and fifth groups are liable to be precipitated, to a greater or less extent, together with those of the third group. The compounds of these metals are retained by adsorption in the precipitate in a form difficult to remove by filtration and washing. Hence the separation is more troublesome and complicated than would appear at first sight.

The chief problems are:

(*A*) The complete removal of such quantities of metals of the other groups as are co-precipitated with the third group metals.

(*B*) The separation of the various metals of the third group from one another and from phosphoric acid.

Classification of the Various Methods of Separation.

(*a*) Methods in which iron, aluminium (and in some cases other metals) are precipitated together, and separated from remaining metals.

(*b*) Methods in which iron is precipitated free from aluminium.

(*c*) Methods in which aluminium is precipitated free from iron.

(*d*) Methods in which iron and aluminium are determined together as oxides, and then separated after fusion with suitable reagents.

(*e*) Methods in which zinc is precipitated free from aluminium, etc.

Two or more methods may sometimes be combined in one analysis, and it is also possible to determine aluminium indirectly, without separation from iron, by titrating the iron in presence of aluminium, having previously determined the combined amount of the two metals.

Summary of Methods.

(*a*) Precipitation and separation of third group (Fe, Al, etc.) together, from other metals.

(1) The metals are precipitated by ammonia in presence of an ammonium salt, preferably ammonium chloride, and separated as hydroxides from the bulk of the 4th and 5th group. A double precipitation is frequently necessary.

(2) The neutral or faintly acid solution is precipitated by sodium or ammonium acetate, the metals being thrown down as basic acetates, washed by decantation and filtered. The separation is somewhat more complete than in the case of precipitation as hydroxides.

(3) A similar separation may be made by means of the corresponding formates.

(4) The nearly neutral solution is digested for some time with barium carbonate in the cold. Al, Fe, etc., are precipitated, leaving Zn and some other metals in solution.

(*b*) Iron precipitated free from aluminium.

(1) Caustic alkali is added in considerable excess. When necessary the iron is first oxidized by Cl, Br, HNO_3, etc., to the ferric condition. Iron remains undissolved as $Fe(OH)_3$, while Al and Zn go into solution as aluminates and zincates. The Al may then be precipitated after filtering, adding to the filtrate excess of acid, then excess of ammonia.

(2) Tartaric acid is added, in presence of which Fe and Al are not precipitated by ammonia, but Fe may be precipitated as FeS free from Al by means of H_2S in presence of an excess of ammonia. The FeS is filtered off and the tartaric acid in the filtrate destroyed by oxidizing, for instance, with $KMnO_4$ or by evaporation and ignition. The Al may then be precipitated by any of the ordinary reagents.

(*c*) Aluminium precipitated free from iron.

(1) In a concentrated solution of the chlorides, saturated with HCl gas, to which an equal volume of ether is added, $AlCl_3$ is precipitated free from Fe and Zn, and may be filtered on asbestos.

(2) The iron is reduced to the ferrous condition by treatment with SO_2 or a sulphite; then, by boiling with a thiosulphate, the Al is precipitated as Al $(OH)_3$ free from Fe.

(3) The iron having been reduced as above to the ferrous condition, aluminium is precipitated in presence of thiosulphate and acetic

acid by means of sodium or ammonium phosphate as $AlPO_4$, free from iron.

(*d*) Methods for separation of aluminium in the mixed oxides of aluminium and iron.

(1) The ignited oxides are dissolved by prolonged treatment with hot concentrated HCl and the metals separated as in the previous methods. It is very difficult to dissolve the oxides in this way if they have been strongly ignited.

(2) The ignited oxides are fused with potassium bisulphate in a platinum or porcelain crucible, the melt dissolved in dilute H_2SO_4 and the metals separated by one of the former methods, for instance, as in *b* (2); on filtering off the FeS, Al, and Ti remain in solution, and may be separated as detailed in a later chapter.

(3) The ignited oxides are fused with potassium fluoride and treated as in (2).

(4) The ignited oxides are fused with caustic or carbonated alkalis, the melt extracted with water, and filtered. Iron remains undissolved as $Fe\ (OH)_3$ while Al, Cr, etc., go into solution. Al may then be precipitated as $Al\ (OH)_3$ free from Cr by acidulating with HNO_3 and adding excess of ammonia.

(5) Where phosphates are present, the ignited oxide and phosphate mixture is fused with sodium carbonate and silica and extracted with water. Al and Fe remain undissolved, together with some SiO_2, while the filtrate contains PO_4, Cr, and a little SiO_2. The residue insoluble in water is then dissolved in HCl, evaporated to dryness to remove SiO_2, taken up with dilute acid and filtered. Al and Fe are then separated in the filtrate by previous methods.

(*e*) Precipitation of zinc and separation from aluminium, etc.

(1) The solution is made alkaline, then sufficiently acid with acetic or formic acid, and zinc precipitated by H_2S as ZnS.

(2) The metals are obtained in solution in dilute H_2SO_4, sufficient sodium acetate or formate added and zinc precipitated by H_2S as ZnS, leaving Al, Fe, Mn, etc., in solution.

(3) The metals are obtained in alkaline solution (as aluminate, zincate, etc.), and the zinc precipitated by H_2S, stopping precipitation when $Al\ (OH)_3$ begins to come down.

(4) The metals are obtained in alkaline solution and the zinc precipitated by electrolysis, leaving the others in solution.

(*f*) Indirect determination of aluminium without separation of iron.

(1) After weighing the combined ignited oxides, as $Fe_2O_3 + Al_2O_3$, they are dissolved by one of the methods given under (*d*) and the iron titrated either by permanganate or bichromate. For the permanganate titration the iron must be obtained in sulphuric acid solution and reduced to the ferrous state, which may be done by treatment with Zn, Al, or H_2S, or a sulphite. For the bichromate titration the iron must be as a chloride and in the ferrous state. The presence of aluminium does not interfere in either case.

(2) In one portion of the substance Al and Fe are determined together as $Al_2O_3 + Fe_2O_3$. In another, Fe is determined alone by titration as in (1) and Al found by calculation.

Chapter III.

Gravimetric Methods for Estimation of Aluminium in Pure Substances.

In the following descriptions it is presupposed that all substances which would interfere with the precipitation of the aluminium in a pure form have been eliminated by one or other of the methods of separation summarized in the previous chapter. We shall now describe in greater detail the procedure adopted in the two gravimetric methods.

(1) Oxide Method.

This is best performed in a slightly ammoniacal solution. Strong bases must be absent, as these redissolve the hydroxide, forming aluminates, from which, however, the aluminium may be completely precipitated as basic carbonate by continued treatment with CO_2. A considerable quantity of an ammonium salt, such as ammonium chloride, should be present. This not only hinders the co-precipitation of zinc, manganese, and other metals, but, when the solution is heated to boiling, converts the $Al(OH)_3$ from a soluble to an insoluble form. Long-continued boiling must be avoided, as this tends to break up the ammonium salts into ammonia, which escapes, and a free acid which redissolves the $Al(OH)_3$. With long boiling, also, the glass of the vessel is attacked and silica introduced.

The general procedure, then, is as follows: If alkaline, the solution is made slightly acid with HCl, 3 or 4 grm. of ammonium chloride added, and then ammonia in slight excess. The liquid is then heated just to boiling and allowed to settle, after thorough stirring. If the original solution is acid, it should be made distinctly alkaline with ammonia, any precipitate formed redissolved in HCl, ammonium chloride added as described, and the liquid then made slightly alkaline with ammonia, boiled, and settled.

One of the chief objections to the precipitation of aluminium as hydroxide is that the precipitate is often of a slimy nature and very difficult to filter. This may be remedied to some extent by the addition of coagulating agents such as tannin, glycerol, starch, or ether. When sodium thiosulphate is used as the precipitant, a quantity of sulphur is thrown down simultaneously. On boiling, this assumes a denser form and renders the precipitate more easy to filter and wash.

When thoroughly settled, the clear liquid is decanted through a filter, and the precipitate washed thoroughly by decantation with hot water containing a little ammonium chloride and a trace of free ammonia. The precipitate is then transferred to the paper and washed with hot water, best under slight vacuum, till the filtrate is free from sodium or other metals. It is not absolutely necessary to wash free from chlorides, provided only ammonium salts remain.

The filter-paper containing the precipitate is then spread out and allowed to dry at a gentle heat, until sufficiently dry to permit of the precipitate being easily detached from the paper. The paper is then burnt to ash, and together with the precipitate ignited, finally at a strong red heat, preferably in a platinum crucible, whereby the hydroxide is converted into the anhydrous oxide Al_2O_3. It is possible to ignite the precipitate, together with the paper, without previous drying, if precautions are taken to avoid loss. The ignited Al_2O_3 is hygroscopic, and should therefore be weighed in a covered crucible.

It is not necessary to use a very high temperature in the ignition, but after the first weighing it is desirable to ignite and weigh again until a constant weight is obtained. Strong ignition is to be avoided if the precipitate is to be subsequently treated with acids, as for example when iron is present, since too high a temperature renders the alumina practically insoluble in acids.

$$Al_2O_3 \times 0{\cdot}5303 = Al.$$

(2) Phosphate Method.

This is generally considered the best gravimetric method for the estimation of aluminium. It has the advantages that the precipitate is more easily filtered and washed than the hydroxide, and that the precipitate obtained is free from iron.

Alloys and ores are treated as already described to obtain a solution containing aluminium. After removal of silica and metals of the second group, the solution, containing not more than 100 mgr. of Al, is neutralized by addition of ammonium carbonate or HCl as required, and any precipitate formed just dissolved by careful addition of HCl. A saturated solution of sodium phosphate or other suitable phosphate is then added containing 2 to 3 grm. of the salt. If no precipitate forms, ammonium carbonate is added until one is produced. HCl is then added cautiously till the precipitate just dissolves, then about 1cc. in excess. Dilute to 300 or 400 cc. with water, add 5 to 10 grm. sodium thiosulphate, heat to boiling, and then add 20 cc. of strong acetic acid. Boil for about 10 minutes to coagulate sulphur. The iron, which is now in the ferrous condition, remains in solution as ferrous phosphate in presence of sufficient acetic acid, while the precipitate formed consists of a mixture of aluminium phosphate and sulphur. After settling for a moment, filter, wash with hot water, dry, ignite with the filter-paper and weigh as $AlPO_4$.

$$AlPO_4 \times 0{\cdot}2219 = Al.$$
$$AlPO_4 \times 0{\cdot}4184 = Al_2O_3.$$

Chapter IV.

Details of Separation and Estimation of Aluminium by Gravimetric Analysis.

In this chapter it is proposed to consider in greater detail the methods outlined in Chapter II, with particulars of their application in special cases. These are merely given as examples, and it must be understood that the procedure may be varied as required to meet the circumstances. In many of these processes it is optional whether the aluminium be determined finally by the oxide or by the phosphate method.

Example No. 1. (Method A 1, Chapter II). Estimation of Al in Aluminium Bronze.

This is essentially an alloy of copper and aluminium, but may contain small quantities of silicon, lead, tin, iron, zinc, and manganese. We shall assume that zinc is present only in small amount, and that the other impurities are only minor constituents.

Dissolve 1 grm. of the alloy in 10 to 15 cc. concentrated HCl with a little HNO_3, then add 5 to 7 cc. of concentrated H_2SO_4 and evaporate to strong white fumes, making sure that HNO_3 is completely expelled. Dilute with at least 50 cc. water, filter, and wash. The residue contains $PbSO_4$, SiO_2, and SnO_2. Dilute the filtrate considerably, heat to boiling, and pass H_2S till copper is completely precipitated. Let stand for some time, filter, and wash thoroughly with warm water containing a little H_2S. The filtrate contains Al, Fe, Mn, and Zn.

Boil to drive off excess of H_2S. Add a few drops of concentrated HNO_3 to peroxidize the iron, and precipitate with ammonia in slight excess. Filter, redissolve the precipitate in HCl, and re-precipitate with ammonia. It is best to add several grm. of ammonium chloride while adding the ammonia to the hot liquid. The second precipitate will be practically free from Zn and Mn. Wash several times by decantation with hot water containing a little ammonium nitrate and ammonia. Finally transfer the precipitate to an ashless filter and continue washing until the filtrate shows no indications of chlorine (test with $HNO_3 + AgNO_3$).

Ignite precipitate as described in Chapter III, and weigh as $Al_2O_3 + Fe_2O_3$.

Example No. 2. (Method A 2. Chapter II). Separation of Al as Basic Acetate and Estimation in Aluminium Bronze.

This method is applicable when zinc is present in considerable amount, but only small quantities of other impurities are present. Proceed as in example No. 1, until a solution is obtained containing Fe, Al, Zn, and Mn. Precipitate this once with ammonia, as described, filter, and wash slightly, then redissolve the precipitate in dilute HCl, avoiding a large excess, and heat to boiling. See that the solution is nearly neutral; if necessary add ammonia till a slight precipitate occurs, then dissolve cautiously with dilute HCl. Add about 5 grm. of sodium acetate or ammonium acetate, boil for 2 or 3 minutes, settle, wash once or twice by decantation, finally transfer to a filter. To the filtrate add 2 grm. more of the acetate and again boil. Filter again if any precipitate forms, and repeat the addition of acetate and boiling until no further precipitate is obtained. The precipitate consists of basic acetates of iron and aluminium, and should be free from Mn and Zn.

Dissolve in hot dilute HCl, add ammonia in excess, and boil till the solution ceases to smell of NH_3. Filter, wash, dry, ignite, and weigh as $Al_2O_3 + Fe_2O_3$.

With regard to the above basic acetate separation, it must be remarked that the separation of zinc and aluminium by this means is more difficult than that of any of the other metals to which the method is applicable. Satisfactory separations of iron and manganese can generally be obtained by one precipitation. The method depends on the assumption that the acetates of certain divalent metals (Zn, Mn, Ca, Mg) are soluble in boiling water, but when a large quantity of acetate is present in the solution, these metals may be precipitated at a higher temperature, and two or more precipitations may be needed for complete separation. The basic acetate of aluminium is particularly liable to carry down other basic radicles such as zinc, by adsorption.*

With regard to the method A 4 (Chapter II), the process depends on the reactions:

$$AlCl_3 + 3H_2O \rightleftarrows Al(OH)_3 + 3HCl$$
$$BaCO_3 + 2HCl = BaCl_2 + CO_2 + H_2O.$$

On filtration, the $Al(OH)_3$ remains in the precipitate while Zn, etc., are in the filtrate. Sulphuric acid must of course be absent, or the precipitate would contain $BaSO_4$. The same writers remark (*loc. cit.*): "Generally speaking, the precipitation is not well suited to the estimation of the trivalent metals. This is a very accurate separation if carefully carried out, provided there is only a small quantity of the two metals in the original solution, but is not a particularly neat and attractive one."

Example No. 3. (Method B 1. Chapter II). Separation of Iron by Caustic Alkali, and subsequent precipitation of Aluminium from the Filtrate.

The substance is dissolved by any suitable method and the iron oxidized to the ferric condition by means of Cl, Br, HNO_3, or $KClO_3 + HCl$, after removal, if necessary, of interfering metals by means of H_2SO_4 or H_2S. The solution is then treated in a porcelain dish with pure caustic potash solution until strongly alkaline, boiled, diluted with hot water, and filtered. Where available, a metal dish, silver, nickel or platinum would be preferable. Wash thoroughly with hot water. [The precipitate contains the Fe, but always retains considerable alkali. Dissolve in HCl, re-precipitate with ammonia, filter, wash with hot water, dry, ignite, and weigh as Fe_2O_3.] The filtrate from the $Fe(OH)_3$ contains the Al as potassium aluminate. Add excess of nitric acid, then slight excess of ammonia. The Al is precipitated as $Al(OH)_3$ and may be determined as Al_2O_3, as described in Chapter II.

Rhead and Sexton (Assaying and Metallurgical Analysis, 1902, p. 324) recommend proceeding as follows: After precipitating copper with H_2S, boil till excess of H_2S is expelled, then add a little HNO_3, and evaporate to small bulk. Pour the solution with constant stirring into a strong hot solution of caustic soda, which must be kept in excess. Rinse the beaker containing the Al solution, adding the rinsings to the soda, boil a short time, dilute,

* See Ibbotson and Aitchison, "Analysis of Non-Ferrous Alloys," 1915, p. 209.

filter, and wash thoroughly, proceeding as described above.

Example No. 4. (Method B 2, Chapter II). Separation of Iron by H_2S in presence of Tartaric Acid and subsequent precipitation of Al from the Filtrate.

The acid solution containing Fe and Al is mixed with 3 parts tartaric acid for each part of the mixed oxides ($Fe_2O_3 + Al_2O_3$) estimated to be present, then H_2S gas passed in till saturated. Then add a very slight excess of ammonia and allow the precipitate of FeS to settle in a closed Erlenmeyer flask. By this means Al remains in solution. Filter and wash with water containing ammonium sulphide. [Dissolve the precipitate in HCl, oxidize with a little $KClO_3$ or HNO_3, and precipitate Fe as $Fe(OH)_3$ by addition of ammonia. Filter, wash, dry, ignite, and weigh as Fe_2O_3.] The filtrate from the FeS is evaporated to dryness with addition of Na_2CO_3 and KNO_3. The residue is gently ignited in a platinum (or nickel) dish to destroy tartaric acid, after which it is dissolved in dilute HNO_3, any carbon filtered off, and the Al precipitated as $Al(OH)_3$ by addition of ammonia, filtered, washed, ignited, and weighed as Al_2O_3.

An alternative method is to boil the filtrate from FeS until H_2S is expelled, add $2\frac{1}{2}$ times as much potassium permanganate as the amount of tartaric acid present, then add SO_2 water until the precipitated oxide of manganese dissolves, then a slight excess of ammonia, and proceed as above. The precipitate in this case may contain manganese and possibly titanium. The procedure in the latter case will be described later (Example 14). Manganese may be separated by re-dissolving in HCl and re-precipitating with ammonia in presence of sufficient NH_4Cl, repeating these operations if necessary, or the basic acetate separation may be used.

Example No. 5. (Method C 1. Chapter II). Separation of Al by precipitation as $AlCl_3$ with HCl gas and Ether.

The following method is given by Gooch and Havens (*Amer. J. Sci. 4*, ii. 416 and vi. 45). See also Ibbotson and Aitchison, Analysis of Non-Ferrous Alloys, p. 210.

A solution of the chlorides of Fe and Al containing about 0·15 grm. of the mixed metals is concentrated as much as possible, then made up to 15 or 25 cc. with concentrated HCl, and saturated with HCl gas. An equal volume of ether is then introduced, after which the liquid is again saturated with HCl gas. This precipitates $AlCl_3$ as crystals, which are collected on asbestos and washed with a mixture of equal parts HCl and ether previously saturated with HCl. The precipitate is dried carefully at 150°C for half an hour, then covered with a layer of pure mercuric oxide, ignited, and weighed as Al_2O_3. By this means crude $AlCl_3$ may be freed from every trace of ferric salt, but there is a possibility of some Al passing into the filtrate. The filtrate contains Fe and also Zn if the latter was present.

Example No. 6. (Method C 2. Chapter II). Reduction of Iron by Thiosulphate and precipitation of Al as Hydroxide free from Fe.

The method depends on the following reactions:

$$AlCl_3 + 3H_2O \rightleftarrows Al(OH)_3 + 3HCl$$
$$2HCl + Na_2S_2O_3 = 2NaCl + SO_2 + S + H_2O$$

The aluminium solution should have a volume of at least 200 cc. for every 100 mg. of Al present. It is neutralized as exactly as possible, and an aqueous solution of 5 to 10 grm. of crystallized $Na_2S_2O_3, 5H_2O$ added. The mixture is then boiled until all SO_2 is expelled, after which a few drops of ammonia are added to produce faint alkalinity, and the boiling continued two or three minutes longer. This has the effect of coagulating the sulphur and facilitating the washing. Filter and wash with hot water. Ignite and weigh as Al_2O_3.

In this process iron is reduced to the ferrous state, but not precipitated, the reaction being:

$$2FeCl_3 + 2Na_2S_2O_3 = 2FeCl_2 + Na_2S_4O_6 + 2NaCl.$$

The method is applicable to chlorides and sulphates but not to nitrates. Rhead and Sexton (Assaying and Met. Anal., p. 329) recommend reducing in the cold with potassium metabisulphite and nearly neutralizing with Na_2CO_3 before adding the thiosulphate.

(To be continued.)

[In the next issue the author will give a number of other examples of estimation by gravimetric analysis. Further chapters will cover the following:

CHAPTER V.—VOLUMETRIC METHODS. Indirect phosphate method, acidimetric method (four variations including the author's modification), iodimetric method.

CHAPTER VI.—GASOMETRIC METHODS.

CHAPTER VII.—EVALUATION OF REDUCING AND PRECIPITATING POWER OF ALUMINIUM DUST. Ferric sulphate method, cupric sulphate method, general standard method.

CHAPTER VIII.—DETAILS OF ANALYSIS OF ALUMINIUM DUST.]

THE CHINA CLAY INDUSTRY OF THE WEST OF ENGLAND.

By HENRY F. COLLINS, A.R.S.M., Assoc.M.Inst.C.E., M.Inst.M.M.

(Concluded from the January issue, page 32).

CHINA STONE.—The distinction between china stone and china clay is widely misunderstood, many people supposing the former to be the rock from which the clay is obtained by breaking down and washing; what in fact has been described by me, for want of a better name, as "china clay rock."

The late Mr. J. H. Collins more than 40 years ago suggested the name of "Carclazyte" for the china clay rock, and that of "Petuntzyte" for the china stone; neither name, however, has come into general use, even among technical writers, and the little memoir on "The Hensbarrow District," published at Truro in 1878, in which these names were proposed, never had any wide circulation outside of Cornwall.

As has been already mentioned in this series of articles, china clay rock is a type of altered granite of local occurrence, found always in close proximity to groups of mineral veins or stringers, and owing its origin to acid emanations and solutions that have come up through the veins, and have been distributed through their agency, the mineralizing agent having been probably hydrofluoric acid. In china clay rock the felspar constituents, where fine-grained, have been almost completely changed into kaolin. Where, however, part of the felspar occurred in large porphyritic crystals, these have frequently resisted alteration to a very considerable extent. Amongst the invariable constituents of china clay rock, besides quartz and kaolin, may be mentioned black tourmaline (the so-called "schorl"), and muscovite, the former in considerable quantities; gilbertite also is very commonly, although perhaps not invariably, present.

Like china clay rock, china stone is an alteration product of granite. It appears to be of much more restricted occurrence, and is not evidently associated with mineral veins. It is hard instead of soft, and the felspar has suffered only comparatively slight alteration, except in the variety that is called "white china stone," which is softer than the other three varieties. Fluor-spar is almost always present, often in considerable proportion, particularly in the varieties of stone known as "hard purple" and "mild purple," whereas in china clay and clay rock it is invariably absent. The most characteristic features which distinguish china stone from china clay rock (after the degree of decomposition of the felspar) are:

(1) Fluor-spar, invariably absent from china clay rock, is always present in china stone, often in considerable proportion, particularly in the varieties known as "purple," which indeed owe their colour to the presence of the mineral.

(2) Tourmaline, so characteristic of china clay rock, is absent from china stone.

China stone, then, is a peculiar type of altered granite, composed chiefly of white or pale brownish transparent quartz, with white felspar, chiefly orthoclase, but with some albite,* which is only slightly decomposed (except in the variety of stone known as "white"), and more or less white muscovite and lepidolite and greenish or yellowish gilbertite. Tourmaline and biotite must be absent since, containing iron, they would spoil the colour of the pottery-ware prepared from the stone. In the quarries it is not uncommon to find inclusions of stone containing biotite; all such portions are carefully picked out and considered waste, for the reason given.

The mode of occurrence of china stone is local, erratic, and peculiar, being confined to a certain small section of the Hensbarrow granite district, most of which is comprised within the north-eastern part of the parish of St. Stephen's. Within this limited district the china stone quarries cover a considerable area, though the rock would not appear to be continuous in its occurrence. It does not occur as definite pipes or dykes intruding into the surrounding granite; nevertheless, the china stone and the granite are generally quite distinct, scarcely ever merging the one into the other by gradations, a mere joint often sufficing to separate typical china stone from well-marked unaltered granite.

Generally the limit between china stone and granite is a vertical or highly inclined joint. Occasionally, however, at an ordinary horizontal or slightly inclined bed-joint, china stone will be apparently "unbottomed" by ordinary granite; at a greater depth this again may give place to china stone. This has indeed hap-

* Generally more than in the ordinary granite.

pened so frequently as to justify a suspicion that in several instances where china stone has been apparently "unbottomed," further sinking might prove that the layer of unaltered rock was only temporary, and not the definite limit of the deposit of "stone." In one case at least a quarry formerly worked near surface for china stone has in depth become a china clay pit, well-developed china clay rock taking the place of the china stone in depth.

It may be said, then, that the china stone occurs within the unaltered granite as large but irregular areas or blocks, which may perhaps be pipes, but if so are accompanied by many extensions into the surrounding granite of sheet and dyke form. The china stone no doubt represents certain segregations from the original granitic magma, which were poorer than the rest in felspar (particularly in orthoclase), and in biotite, and richer in quartz, in muscovite and lepidolite, and probably in plagioclase. Whether the fluor-spar was an original constituent it is hard to say, but in view of the rarity of mineral veins, which elsewhere in the granite have introduced tourmaline, its comparatively uniform distribution throughout the china stone area is difficult to explain upon any other assumption. Topaz is a frequent constituent.

COMPOSITION OF CHINA STONE.—The first three of the following analyses are taken from the memoir already cited.*

	%	%	%	%
Silica	73·39	69·50	71·66	66·70
Alumina	16·50	17·85	18·79	21·45
Iron	tr	tr	tr	tr
Lime	0·50	2·66	1·70	1·49
Magnesia	0·31	0·12	0·35	0·08
Alkalies (chiefly potash, with some soda)	7·66	7·98	6·60	8·01
Fluorine	0·74	0·71	0·14	und.
Water	1·25	1·30	0·91	2·22
	100·35	100·12	100·15	99·95

The high proportion of alkalies indicates the comparatively small amount of alteration undergone by the felspar, for the average ratio of alkalies to alumina in the above analyses is 1 to 2·46 as against 1 to 1·3 in the case of unaltered orthoclase, that is to say, that barely one-half of the alkali of the felspar has been removed.

METHOD OF WORKING.—The fact that china stone is hard, and virtually a peculiar type of granite, occurring in masses or areas of a certain extent, indicates that it is worked by ordinary quarrying methods. The topography of the region where it is found being that of a plateau, the quarries all take the shape of pits sunk below the surface, worked by steam cranes (more rarely by Blondins) with surface tramroads for removing the broken rock to road loading-stations, or more usually to a railway siding. There are a very large number of quarries, but few of them extend over an area of more than 1 or 1½ acres. Pumping is only required for the surface water, and rarely requires any extensive plant; generally a small portable steam pump, or a small Cornish 4 in. to 8 in. bucket lift is found sufficient, the source of power in either case being usually a portable boiler.

In most cases the greater part at least of the valuable china stone is overlain by from 10 to 20 ft. or more of ordinary granite, worthless for any other than rough building purposes, which has to be removed to waste.

USES OF CHINA STONE.—Being softer and much more readily worked than ordinary granite, china stone has been largely used in the district as a building stone; several of the fine local churches (for instance, St. Stephen's and Probus) have been built of this stone. At a temperature of about 1,200°C. it softens to a viscous melt, which upon solidifying becomes a pure white opaque "frit" or vitreous mass resembling enamel, of which material indeed this stone always forms the preponderating constituent.

Any flakes of mica present in the original stone (particularly if of biotite) remain as discoloured and frothy spots in the frit. Any parts of the stone as quarried which show much mica ("shell") are therefore carefully picked out and rejected, stone of doubtful appearance being tested by placing a few fragments in a clay crucible, igniting in a blacksmith's forge, and inspecting when cold the resulting melt, which should be perfectly smooth and white, free from "pinholes" or frothiness.

A considerable part of the entire output is cut into rectangular blocks, which are used for paving the drag grinding pans in which potters grind the ingredients for their various pastes or slips, as well as for the grinding blocks used in the same. The remainder is either sent in lump form to the Staffordshire Potteries, or is sent to grinding-mills in the same neighbourhood, built of the same stone, and driven by water power, where it is wet-ground to a fine slurry, settled, dried like china clay, packed in casks, and sent away to the Potteries.

OUTPUT.—The use of this material in the Potteries is somewhat limited, and although it has shown variations during the past 20 years, cannot be said to be much on the increase. Before the war the output ranged from 60,000 to

* J. H. Collins: "The Hensbarrow Granite District," Truro, 1878

70,000 tons per annum. Comparatively little of it goes to foreign countries, most of which possess indigenous sources of supply of quartz-felspar rocks, free from iron, a variety of which can be utilized in place of china stone to perform similar functions, although without the advantage possessed by the Cornish stone of melting at an exceptionally low temperature, a property conferred upon it by its fluor-spar content. A somewhat similar rock, except for the absence of fluor-spar, is quarried in Jersey and used for similar purposes to the Cornish stone. The aplite of Meldon, near Okehampton, is another instance of a quartz-felspar rock employed as a substitute for Cornish stone.

CLASSIFICATION.—Four classes or qualities of china stone are recognized, namely: (1) hard purple, (2) mild purple, (3) white, and (4) buff.

The most highly esteemed is the first, which has the highest proportion of fluor-spar, and in which the felspar has suffered least alteration. The "mild" purple contains less fluor-spar, and the felspar has suffered more alteration; it may be looked upon as the intermediate grade between "hard purple" and "white." The latter contains less fluor-spar, and its felspar through decomposition has become white, opaque, and friable. It is the most infusible kind, and therefore least esteemed, since the same effect can be produced by mixing purple stone with a certain amount of cheaper admixture, for example, a mixture of china clay and ground flint. The buff stone is like the white, but slightly tinted with yellowish iron stain. This variety does not burn white enough for use in glaze or enamel, but makes a good binder in body work.

SELLING PRICES AND COST OF PRODUCTION.—Before the war the selling prices of the rough broken stone ranged from about 16s. to 19s. 6d., which left a profit of from 3s. to 4s. 6d. per ton, working costs varying between 13s. and 15s. per ton. Of the gross selling price, roughly 26% represented wages, 29% covered coal, transport, depreciation, rates and taxes, and general maintenance charges, while no less than 24% of the gross selling price went to the landlords, and 21% to the operator for his profit. The royalties were levied upon a sliding scale in proportion to the selling price, and ranged from 3s. 6d. to 4s. 3d. per ton, certainly a very high rate of royalty upon a material of such low value, upon which, moreover, the dead charges for opening up the quarries and removing waste overburden are always heavy.

CHINA CLAY AND CHINA STONE IN POTTERY.—China clay by itself is very refractory, and at the highest temperature obtainable in a muffle shows no sign of melting, but shrinks uniformly, and agglomerates to a hard solid porous biscuit with but slight incipient vitrification.

It forms an essential basis of all white pottery-ware, especially of those goods in which the pure white colour is an integral part of the ware. For those wares which do not depend for their colour upon the body itself so much as upon an opaque white glaze, the greater part of the china clay can be replaced by so-called "ball clays," which are not of such pure white colour when fired. Those clays have the advantage of being not only cheaper, but more plastic, so that they are more easily worked; they are also somewhat more fusible than pure china clay, so that they show a greater tendency to vitrify at the temperature used in ordinary pottery kilns.

With china clay, at the temperature of ordinary pottery kilns, a sufficient tendency to vitrification can only be secured by the admixture of substances which fuse at such temperatures, such as felspar.

Reference has been made to the fact that at a temperature of about 1,200°C. china stone (unlike china clay) melts to a pure white enamel or "frit." This fact renders china stone a desirable ingredient as a binding agent in most body-mixtures, and an almost essential constituent of glaze or enamel mixtures. In the former, being more fusible than the remaining ingredients, it acts as a vitrifier, agglomerating the particles, and rendering the mass less porous. In glazes it is one of the more infusible ingredients, and acts to some extent as a stiffener, having the advantage that the "frit" which it forms of itself contracts and expands by changes of temperature less than some others.

Scores of formulæ are in use for making different classes of "body" for pottery work. There are two main classes of body used in white pottery, namely, porcelain and white earthenware. The latter is essentially white clay mixed with some sandy substance like ground flint to diminish shrinkage, and with a little fritting material like china stone, to act as a binder. It is moderately dense, with a porous, granular fracture, presenting no sign of fusion.

Hard porcelain, on the other hand, is essentially an intimate mixture of clay and glass; it is more dense than the earthernware body, and its fracture is vitreous, smooth, and velvety. For this body china stone is seldom

Typical Body Formulæ.

	Hard porcelain	English bone china	Earthenware body cream	Earthenware body white	English white stone-ware		English granite-ware
China clay	65	30	10	[illegible]	[illegible]	30	25
China stone	—	20	8	[illegible]	10	45	10
Felspar	20	—	—	—	—		
Ball clays	—	4	70	60	[illegible]	15	25
Flint	10		12	20	18	10	40
Bone ash	—	46	—				
Chalk	5	—	—	—	—	—	—

used, its place being taken by felspar, which is still more fusible. The composition of Sèvres porcelain body is given below.

Soft porcelain and English bone china are intermediate, with appearance between hard porcelain and white earthenware; the latter is the softest of all the bodies in use. English white stone china again is harder, semi-transparent, like soft porcelain, but somewhat more granular in fracture; it is stronger (less fragile) than porcelain, although fired at a lower temperature.

The table above gives typical body-formulæ, all calculated for 100 parts.

It will be understood, however, that an infinite number of variations are possible, and frequently other ingredients are introduced, particularly into the so-called "stone china" bodies, such as blast-furnace slag, and broken flint-glass.

Glazes.—Porcelain glaze is little but pure felspar, crushed fine and made into a slip. The glaze for all china-ware, stone-ware, and earthenware often contains lead or tin, but in any case china stone forms an essential part of it, generally from 20% to 25% at least. It will be seen, therefore, that china stone (or its equivalent) is almost as essential a feature in English pottery as china clay itself, although in the composition of all body mixtures, with the exception of stone-ware, it is used in smaller proportion than china clay.

NEWS LETTERS.

TORONTO.

January 13.

Mineral Production of 1919. — An official estimate of the mineral production of Canada for 1919, issued by the Division of Mineral Resources and Statistics of the Department of Mines, gives the total value of the year's output as about $167,000,000, as compared with $211,301,897 for 1918. The falling off is due to the sudden cessation of the extraordinary war demand for steel, copper, nickel, and other metals. The only noteworthy increase was in the gold output, the value of which was $16,275,000 as against $14,463,689 for the previous year. The production of coal dropped from 14,997,926 tons to 12,500,000 tons.

Dividends by Gold and Silver Mines.—A revised statement of the dividends paid by the Northern Ontario mines during 1919 shows disbursements by silver mines to the amount of $4,882,341, and by gold mines $2,461,542, a total of $7,343,883. The total dividend payments since the beginning of the industry to the end of 1919 were as follows: Silver mines $81,003,616, gold mines $15,753,752, total $95,757,368.

Cobalt.—The life of the Cobalt camp, which a year or two since appeared to be gradually drawing to its close, has been indefinitely extended by the high price of silver, which has rendered commercially valuable large quantities of low-grade ore formerly passed by as waste. Several of the mines which were regarded as nearly worked out are now going over their old workings and taking out good milling ore. Arrangements are being made to re-open several properties which had been closed down as unprofitable, and the new year finds the industry in a highly active and prosperous condition. The production of the Nipissing for December was the highest in the history of the company; the ore mined had an estimated value of $423,139, and bullion and products shipped from Nipissing and custom ores had an estimated net value of $449,758. The Crown Reserve has latterly considerably improved its position, having extracted large quantities of high-grade ore from the rich vein found on the 150 ft. level. It is proposed to work a large section of the old workings, which carry lean ore, on the quarrying system of extracting large blocks with a prospect of finding some high-grade in addition to the milling rock. An action brought by the O'Brien mine against the La Rose Consolidated to determine the boundary between the Violet property of the latter and the O'Brien having been decided in favour of the La Rose, an appeal has been made against the judgment. The strip of land in question is believed to be very valuable. The McKinley-Darragh, which is treating its accumulated tailings on an extensive scale by the oil-flotation process, is making a strong effort to keep its equipment in operation throughout the winter, instead of closing down as is usually done. The Kerr Lake during December produced about 106,000 oz. of silver, averaging some 3,400 oz. per day. Among properties which will shortly be re-opened are the Right of Way and the Hylands, the latter of which has been acquired by the Victory Silver Mines, a new company.

PORCUPINE.—The Dome Mines has considerably increased its working forces, and now gives employment to 350 men. The mill is treating about 950 tons of ore daily. Operations are being actively carried on by the company at the Dome Extension adjoining, on which it holds an option terminating in March. Speculation is rife as to whether it will be exercised, and it is supposed that this will depend largely on the result of explorations now being carried on. A large ore-body, stated to be 100 ft. wide at its widest part and to carry ore believed to average $5 per ton, has been encountered on the 600 ft. level. Diamond-drilling has been undertaken to ascertain whether this deposit continues down to the 1,150 ft. level, and the result of the exploration may be a deciding factor as regards the exercise of the option. An unofficial estimate based on official figures for the first 36 weeks of the year places the total output of the Hollinger Consolidated for 1919 at approximately $7,000,000, as compared with $5,752,370 in 1918. It is now treating about 2,800 tons of ore daily. Among recent improvements tending to the reduction of operating costs is a change of the main haulage from the 425 ft. to the 500 ft. level. At the Davidson Consolidated an ore-body carrying high-grade ore 32 ft. in width has been encountered on the 500 ft. level. The shaft of the Clifton Porcupine has reached a depth of 200 ft., and a substantial amount of good ore has been developed. At the Keora arrangements have been made for putting a central shaft down 250 ft.

KIRKLAND LAKE.—This field is attracting the attention of many American capitalists, and some important transactions are being negotiated. At the Kirkland Lake mine rich ore is being developed at the 700 ft. level, the deepest working in the district. The ore-body, which is 6 ft. wide, has been opened up for 100 ft. The shaft on the Kirkland Combine is down about 75 ft., the vein continuing to show good gold content. A level will be run at 200 ft. The Wright-Hargreaves is bringing in machinery for the mill which will be installed in the spring. At the Ontario-Kirkland 1,500 ft. of diamond-drilling will be done from the 300 ft. level to determine the continuation of surface outcrops at depth.

GOWGANDA. — Much attention has been attracted to this district by the success of the Trethewey of Cobalt in the development of its recently acquired properties. A rich vein found on that known as R.C. 101 has more than paid the expenses of sinking the shaft by the high-grade ore extracted. The management has decided to concentrate work on this vein, and it is being followed up on the 108 ft. level. There are other promising veins showing on the surface. A mining plant has been installed at the Silverado, where lateral work will be undertaken at the 100 ft. level to tap several veins. At the Kells claims, for which an American syndicate recently paid about $200,000, a steam mining plant is being installed. There is considerable high-grade ore in sight. Work on the Camburn property has been discontinued.

KALGOORLIE.

November 1.

HAMPTON PLAINS.—Your readers will have been posted with full details of the discovery on Block 50, Hampton Plains, and will know that the Government Geologist, Mr. A. Gibb Maitland, had given it as his opinion that the lode could be correlated with the Kalgurli lode, not with the Great Boulder and Ivanhoe lodes. Mr. Maitland said he based this opinion on the report made by Mr. Sydney S. Honman on the district. Mr. Honman has just issued a statement on this subject in which he says that Mr. Maitland should not have read this interpretation into his report, and that in fact, having acquired further information and experience since he made the report, he (Mr. Honman) now believes that the Celebration formation is on the actual continuation of the Boulder-Ivanhoe-Horseshoe ore-channel. His statement is given in the following paragraphs.

"In view of the report by the Government Geologist on the new find at Hampton Plains, and the inference conveyed by that report that his conclusion that the Celebration Mine is not on the Boulder-Ivanhoe-Horseshoe ore-channel has been based on Bulletin 66, of which I am author, I am impelled to make public my views.

"In describing the rocks of the district in Bulletin 66, I take them in historical order, and deal with the oldest rocks first, as follows :

"Greenstones (volcanic) of the Golden Ridge belt, the Feysville belt, the Somerville-Woolabar belt, the Mt. Marion-Yilima trig belt; porphyrite (volcanic); sedimentary, representing periods of volcanic inactivity.

"The classification of the volcanic greenstones into the Golden Ridge, Feysville, Somerville-Woolabar, and Mount Marion-Yilima trig belts, applies only to the series prior to intrusion and ore deposition.

"The above series of rocks after all volcanic action has ceased, have been folded, tilted on end, sheared, and subsequently intruded by a series of later intrusives; first by peridotites (now serpentines), then dolerites and gabbro, quartz-porphyries and porphyrites, granite, and finally by new gabbro (norite). Before these intrusives were forced into the volcanic series no ore deposition could have possibly taken place, as is recognized generally by both scientists and practical mining men. It is clear, therefore, that under no consideration whatever could the volcanic greenstone belts be classed as ore-channels, as the Government Geologist infers.

"At Kalgoorlie a report by Mr. C. G. Gibson shows that a certain series of rocks occurs from west to east, namely, prophyry, sedimentary, rocks, amphibolite, fine-grained greenstone, porphyrite, serpentine (peridotite), amphibolite, quartz-diabase of the Golden Mile, calc schists, fine-grained greenstones and sedimentary rocks again. At Block 50 a section across the Celebration leases shows the following series from west to east: Porphyry, sedimentary rocks, amphibolites, serpentine (peridotite), fine-grained greenstone, quartz-dolerite (which is the quartz-diabase mentioned by Gibson), calc schist, gabbro, fine-grained greenstone (including porphyry), and sedimentary rocks on the east again. The cross-sections above enumerated are at both places approximately the same width, and the series as far as is consistent with their distances apart practically identical, and in each case the lodes occupy the same relative position.

"From a study of the map in Bulletin 66, it is clear that there is only one possible course along which the continuation of the Boulder-Ivanhoe-Horseshoe ore-channel could run, and that is in proximity to the dolerite, porphyry, and serpentine intrusions, which follow a well-defined belt of country passing through Blocks 50 and 48. It was chiefly upon this fact that I based my predictions seven years ago, that lodes would be found in Blocks 50 and 48.

"It is apparent that the Government Geologist has not read Bulletin 66 very closely, or he would never have conveyed the idea that the ore-channel of the Celebration leases is coincident with the Somerville-Woolabar volcanic belt. His statement that the discoveries in Blocks 50 and 48 are not on the extension of the Boulder-Ivanhoe-Horseshoe ore-channel is inexplicable in the face of the fact that all the known field evidence supports the suggestion in my Bulletin 66, that it is a continuation of that channel.

"Since writing Bulletin 66 I have acquired a first-hand and an intimate knowledge of the geological conditions of the whole of the eastern goldfields, and I have now no doubt that the Celebration formation is on the actual continuation of the Boulder-Ivanhoe-Horseshoe ore-channel, and that it is a lode of the true Kalgoorlie type. The evidence upon which my conclusion was based has been further supported by a geological reconnaissance since my return to the district, of the country to the east and south-east of Block 50, also the discovery on the western and southern boundaries of the same block of a considerable development of serpentine (peridotite) occupying a corresponding position in Block 50 to Gibson's serpentine in the Kalgoorlie series.

"Among the evidence in support of my conclusion, the following are of special significance:

"(1) Those rocks in the neighbourhood of the Celebration leases that have been definitely recognized and located are similar to and have the same relative position to each other as the rocks of the Golden Mile.

"(2) The Celebration leases are in a belt of country which owes its topographical relief (forming a continuous range of hills from Kalgoorlie to Red Hill) to the presence of later intrusives having relatively higher resistance to erosion than the volcanic sedimentary series on either side of it.

"(3) The valley extending from between Kalgoorlie and Golden Ridge and west of Mount Martin to Lake Lefroy is parallel to the only possible broadly defined greenstone belt in which the Kalgoorlie rocks can occur, and follows the belt of easily erodible sedimentary rocks on the eastern margin of that belt.

"(4) The Celebration formation has all the characteristics of the true Kalgoorlie lodes.

"(5) Porphyry dykes, which are one of the main characteristics of the Kalgoorlie ore channel, occur in the belt in which the Celebration lode occurs, and in close association with quartz dolerite, which is the same as Gibson's quartz diabase at Kalgoorlie.

"(6) The oldest intrusive rock, serpentine (peridotite), occurs to the west of the Celebration mine, and from all available field evidence is continuous with the serpentine to the west of the Boulder-Ivanhoe-Horseshoe ore-channel. No other serpentine has been discovered in the greenstone belt outside of the belt of country running through the Boulder to Block 50.

"(7) The distance of the Celebration lease from the western margin of the volcanic series is the same as that of the Golden Mile from the same margin up north.

"All the above evidence is available in Bulletin 66, except the occurrence of serpentine in Block 50, which was not mentioned on account of that being a report on a general survey only."

DERBYSHIRE.

MILL CLOSE MINE.—This famous old mine has been worked continuously since 1859 in the hands of one family, the heirs of the late Mr. Edward Wass. Taking the output over the whole period of sixty years it has been the largest lead producer in the United Kingdom, falling to second place only during the past few years. Large profits have been earned, especially during the last 25 years. Relations between the owners and the workpeople have always been of the most friendly and quasi-paternal character up to the war period, when the two most active trustees were prevented by their military duties from giving their personal attention to the undertaking. Some three years ago certain claims of the men in regard to wages did not (owing to the reason just mentioned) receive immediate and sympathetic attention, with the result that the men formed a local branch of the Derbyshire Miners' Association, a colliery union. Since that time, strike has followed upon strike, efficiency was lowered pari passu with increases in wages, and when the price of lead fell away after the armistice the trustees found themselves not only involved in constant worries, but, for the first time in the history of their trust, making no profits. In view of this, coupled with the fact that their existing lease would expire early in 1920, the trustees decided to offer the undertaking for sale as a going concern. The sale has now been completed, the purchaser being Mr. Frederick Chambers, managing director and one of the principal owners of the Stanton Iron Works, who also owns a lead-pencil factory, and is interested in various other industrial undertakings. The amount of the purchase price has not been disclosed, but it is large; it is not yet decided whether the new owner will continue to work the property as a private concern or whether a company will be formed to work it. It is noteworthy that the late owners have decided to divide a sum of £10,000 among their employees as a token of their appreciation. Such generosity is, unfortunately, not common in this class of business transactions, and is therefore the more to be commended.

The history of the last strike at Mill Close is not without general interest. Some six months ago the owners decided to cut down the underground working force, in consequence of the non-profitable character of some of the working places at the then-prevailing price of lead. The local branch of the Derbyshire Miners' Union (affiliated to the Miners' Federation) thereupon claimed the right to dictate which of the men should be laid off, and, in particular, that two non-unionists employed in other working places should be discharged before any men belonging to the Union. After three years' experience of giving way in a vain effort to secure peace, the owners felt bound to resist these claims, and the underground men went on strike, being soon joined in sympathy by a part of the surface hands, including most of the stokers, and the men at the smelting works five miles away. The owners, after consultation with their staff and advisers, decided to carry on as a non-union concern. After one week's idleness a first underground gang was made up from the shift-bosses, the two non-unionists, and a few of the loyal surface hands who had formerly been miners, the total being 11 men. Notices were issued inviting any of the striking miners to apply individually for re-engagement, but these produced no effect. Applications were, however, received from discharged soldiers, who, although ignorant of mining, were willing to learn under skilled tuition, and, as engaged, these men were sent below, each "new" man being paired off with an "old" one. After the first week underground work never ceased, although at first the dressing plant could not be run for more than 3 days each fortnight, and even for that some of the underground men had to be withdrawn to help. By early in November, thirteen weeks after the strike broke out, the underground gang had increased to 27 men, including 16 inexperienced discharged soldiers, and the dressing plant was able to run for three days each week without interfering with any of the work underground.

The position in January is that the mine is being carried on with 27 men underground as against 85 previous to the strike, the output of lead concentrates being between two-thirds and three-quarters of the normal. Ore-getting and tramming work underground was formerly on bargain or contract, coupled, however, with a minimum wage fixed by arbitration at a level so high as to destroy the incentive of those gangs which contained some inefficient workers, or whose members were not particularly energetic. All men underground are at present paid a rate of day-pay which is higher than the former minimum wage, and is supplemented by a bonus on output, which is variable and voluntary on the part of the owners.

The "efficiency" of the non-union men underground (16 of whom out of the total of 27 are unskilled labourers), that is to say, the output of ore-stuff raised per man employed, is much greater than that of the supposedly all-skilled union miners on contract under the operation of the minimum wage. In the case of one stope, where the working conditions have remained identical, and where therefore exact comparison is possible, 3 new men and the same number of old men now turn out 80% more stuff than did the 6 union men on contract who formerly worked the stope.

Since the above was written the most recent development is that some of the best workers among the men who have been so long on strike have left their Union and have applied individually for work. The total number of employees underground is now 40 and the new standard of efficiency is fully maintained.

CAMBORNE.

KILLIFRETH.—In my letter last month, I referred to the provision of new capital for this mine. It appears that the capital is to be increased to £125,000 by the issue of 25,000 shares of £1 each. These shares are to be issued to the shareholders at par, subject to a commission of 4s. per share, but as the issue has been underwritten for a 5% commission, the money is certain to be forthcoming. The issue will provide £18,750, which is by no means too much to bring the concern to the profitable stage, seeing that the mine is not unwatered below the 50 fathom level, and also that the milling plant is only on hire. From the local manager's report dated December 30 last, it would appear that about 5,000 tons of ore of an average grade of 45 lb. black tin per ton has already been developed in the upper levels, and the development points now in operation show considerable promise; while, as the mine is unwatered, there is every reason to believe that pillars of payable ground will be met with. The lodes vary from one to three feet in thickness, but are often very rich, one end on the Middle lode being said to be worth at present £200 per fathom. The future programme of the management is to unwater the main lode to the bottom workings and to sink the Richards shaft to get under the ore courses worked by the old company, but in the meantime the ground already unwatered will be developed and the ore therefrom sent to the Wheal Busy mill for treatment. Under the able guidance of Mr. Arthur Richards, and given adequate capital, we have every confidence, knowing intimately the past history of the mine, that this undertaking will justify its present-day promise.

H.M. INSPECTOR OF MINES.—The industry will learn with regret of the transference of Mr. T. Boydell to the North Staffordshire district, although, as the change is due to promotion, this is perhaps a selfish view to take. During the difficult period through which the industry has passed owing to the war, Mr. Boydell proved a staunch friend in many directions, and as President of the Mines Recruiting Court did yeoman service, in his usual unostentatious way, to the entire satisfaction of all concerned.

PERRANPORTH MINES.—A nasty accident recently occurred at this mine, formerly known as Droskyn, and situated on the cliff at the little seaside resort of Perranporth. The main shaft is being unwatered by a company which was formed in 1918 by the late R. H. S. Henderson-Bull. Owing to trouble with the lift, some of the pumps were being hoisted to surface, when the connection broke and they fell down the shaft. Everything was stripped—footways and landings—and the men engaged in the shaft had miraculous escapes, only one being injured. It is to be hoped that this accident will not result in the suspension of operations, as the reports indicate this to be a proposition of great promise.

DING DONG MINE.—It is reported that this ancient tin mine, situated at Madron, north of Penzance, is to be reopened. A few years ago, the extensive dumps on this property were worked with some small measure of profit when the price of tin was less than it is at present, but, with the fall in price, operations had to be suspended. There is in this extensive property a large deposit of china clay, which has already been tested to some extent by pitting, and this certainly justifies a more thorough examination. It is stated by the "old men" that when the mine was being worked some fifty years ago, great difficulty was experienced in keeping some of the levels open, owing to the soft clayey nature of the ground.

POLDICE.—The recently issued report of the Berrida (Nigeria) Tin Fields, Ltd., gives information as to the progress made in the erection of the plant which is being installed to treat the extensive ore dumps on this property. Thirty California stamps have been erected capable of dealing with 150 tons per day, while two pneumatic stamps are on the property ready for erection if required. It is stated that by sampling the various dumps, the bulk of the mineral values are contained in those portions (estimated at 75% of the whole) which will pass through a $1\frac{1}{2}$ inch mesh screen, and that this material can be supplemented by ore to be raised from the mine above the adit level. On starting the first portion of the plant last September, certain structural alterations and rearrangement of the plant were found to be necessary, these necessitating the provision of further working capital. This was provided by an issue of £50,000 seven per cent debentures, half of which was applied to secure advances already made. Subsequently additional funds were found to be needed, and a further £10,000 was provided by means of prior lien debentures. Up to December 18 last, 3,800 tons of material treated gave a chemical assay of approximately 14 lb. of black tin and 10% of arsenic per ton, apart from wolfram and other mixed minerals. If the dumps (or rather the fines previously referred to) as a whole will assay as well as the stuff put through in this trial, the financial result at present prices should prove most satisfactory. Quite frankly we have grave doubts on this score, but we hope we may be proved to be wrong. Nothing is said in the report of the results secured by the use of the Morley Martin glass-topped tables, and we await with interest the publication of data in this connection. We understand that Major Hannay, the local manager, has resigned or is about to resign.

SOUTH CROFTY.—In the last issue, we referred to the strike of employees at this mine for the purpose of forcing all the men into the Workers' Union. In this they were successful, but it brought about another result with which it is doubtful if they are equally pleased. This company—prior to the drop in the price of tin and wolfram following the end of the war—paid its employees a bonus on the monthly profit earned, and in December last the resumption of profit-earning enabled the directors to announce the re-establishment of this bonus for 1920. However, as a result of the strike, it is now announced that what was intended to give pleasure has evidently caused dissatisfaction, and "in view of the decision of the meeting of the Industrial Council that all mines should act in unison, this company feels that they must keep strictly in line with other mines and that they must for the present withdraw the proposal to re-establish the bonus until such time as the question of the profit-sharing bonus has been considered by all the mines and placed on a standard basis."

GIEW MINE.—As further evidence of the dictatorial spirit animating the Unions just now, we have the recent short strike at this mine. The management discharged two lorrymen for disregarding orders, and the employees "downed tools" until they had been reinstated, as in their opinion the men had been unjustly discharged. Temporarily the pumps were stopped. In the end the management agreed to reinstate the men in question and the strike ended.

CRAFT UNION.—For some time past there has been dissatisfaction on the part of some of the members of the two Unions operating in Cornwall on the ground that both are organizations of unskilled labour, run by officials who have no practical experience of mining. As a result, there has recently been formed a Metalliferous Miners' and Quarrymen's Union, which is to cover the whole country, and already a branch has been formed at St. Just, which seems to have attracted a fair measure of support. The leading spirit appears to be Mr. Joe Terrett, who is prominently connected with the National Democratic Party, and already he is airing in the public press his limited knowledge of the industry, and showing to his own satisfaction how it ought to be conducted. Doubtless, like his confreres of the other Unions, experience will temper his enthusiasm. Obviously the advisability of joining this new Union is a matter for the men themselves, and we have some sympathy with those who wish to join an organization which is not controlled chiefly in the interests of dock labourers, but it has to be remembered that the local leaders of these dockers' unions have done much to improve the condition of those of their members who are connected with the mining industry, and, too, that they have learnt by experience that reforms must come slowly. The industry is at present in no condition to bear the burdens which Mr. Terrett would place upon it.

HEMERDON MINES.—In another part of this issue will be found an article dealing with this property and its equipment. It is most unfortunate that the price and demand for wolfram for some months past has been such as would not permit even this cheaply-worked deposit to be operated at a profit, and, as the Chairman said at the recent shareholders' meeting, it has been cruel bad luck that by a combination of circumstances, over which the management have had no control, the opportunity has not yet been afforded the directors of justifying their belief that this virgin property will prove to be a highly profitable proposition. Largely on pressure from the Ministry of Munitions, a plant capable of treating 400 tons of ore per day was installed, and there can be little doubt that, but for the end of the war and consequent slump in wolfram, this company would easily have been the largest producer in the country. During the past year, to secure information as to the depth and thickness of the deposit, an adit was started from the lowest point at which mineral had been proved. This adit is now in a distance of 73 fathoms, and at the face now underneath the entrance to the quarry, the vertical height to surface is about 50 ft., so that in all 80 ft. in thickness has been proved. The managing director estimates, on the basis of a recoverable value of 10·28 lb. per ton (which is the average of vanning assays over 10 weeks of the ore removed from the adit) and taking the deposit at a thickness of 100 ft. over the $17\frac{1}{2}$ acres already proved, that there is a total of 5,863,846 tons of ore available, or 70 years' supply for the existing mill. These are stupendous figures, and we should hesitate, on the basis stated, to accept them, but there can be little doubt, from the testing already carried out, that there is a big tonnage available. The total operating cost is figured at 8s. 10d. per ton.

JOINT INDUSTRIAL COUNCIL.—At the last meeting of this body, Mr. J. Harris (of the Workers' Union) was appointed chairman for the current year, following Mr. C. A. Moreing, who acted in that capacity for 1919. We notice that the question of the high price of coal and its effect on the industry was discussed, and it was decided to make representations to the Coal Controller and the Government Departments concerned. We would suggest that the time to have made such representations was in October last when a special Commission was appointed by the Government to consider the question of railway rates, for carriage forms quite a large proportion of the total cost. The agricultural industry, as a result of vigorous representations to the Commission, secured a distinct advantage, for in their case it was decided not to increase the rail rates. Some such concession might have been secured for the Cornish mining industry had its representatives been more alert, but as usual no step was taken until it was too late. What is the Chamber of Mines doing to allow this and other matters vitally affecting the industry to be decided without a word of protest? What is the use of a Chamber of Mines unless it closely watches the interests of the industry as such interests are affected by the legislation and schemes of the Government? Shortly the new Unemployment Insurance Bill will be under discussion in the House of Commons; has the Chamber of Mines yet had under consideration the question of the advantages or disadvantages of having a special scheme for the Cornish mining industry as is proposed to be permitted under the draft bill? It seems likely that the question of local rating for mines and quarries will be reviewed in the near future in view of the increase of the "no profit, no dues" policy as applied to mine leases; has the Council of the Chamber given this question any thought?

CALLOOSE TIN MINES & ALLUVIALS LIMITED.—This company has recently been formed with a nominal capital of £125,000 to acquire leases of the Trevaskus, Wheal Hope, Fraddam, Wheal Providence, and West Wheal Treasury mines, situated in the Gwinear district, together with certain other licences and a mill capable of treating 3,000 tons of ore per month. The purchase price was £110,000, payable £30,000 in cash, £15,000 in six per cent debentures, and £65,000 in fully paid shares. The issue to the public was 240,000 shares of 5s. each at par, and we understand this sum was subscribed. After paying the cash portion, £30,000, of the purchase price and £5,000, the estimated amount of the preliminary expenses, the net sum available for working capital is £25,000. The properties acquired are some of those which Mr. A. F. Calvert and his friends have been testing for some time past, and the prospectus, as might be anticipated with a Calvert flotation, was presented in a form likely to whet the appetite of a not too critical public. Voluminous reports of a small army of officials employed at the mines accompany the prospectus, and while expectations are freely set out, there seems to be little actual data available to show how the estimates of reserves are arrived at. There is stated to be (1) an estimated body of 600,000 tons of ore above water-level averaging 22 lb. of tin per ton, and millions of tons in depth, (2) dumps of mill tailings and rock ores at surface, estimated at 1,212,000 tons, of which tailings alone contain an estimated average of 12 lb. tin per ton, (3) large bodies of rich ore exposed in the Unity lode, averaging 60 lb., and in the Red lode averaging 55 lb. per ton, (4) an alluvial deposit, of which the reports state that 48 acres have been proved to a depth of 8 ft., estimated to give 619,488 cubic yards of alluvial containing an average of $8\frac{3}{4}$ lb. per cubic yard. As regards (1), the ore-body referred to is the Great Trevaskus lode, about which the manager, W. R. H. Hereford, says, "all the old workings (that is, above adit level) are now in course of being systematically sampled. The values in this, the upper portion of the lode, as might naturally be expected, are found to be patchy, the values ranging from 12 lb. to over 100 lb. of tin oxide per ton." That this lode is patchy is confirmed by Henwood, in the Transactions of the Royal Geological Society of Cornwall, and quoted in "Observations" by the late J. H. Collins; he says, "in some spots there are small quantities of oxide of tin, arsenical pyrites, galena, and blende.' It is not stated by Mr. Hereford that this ore-body has been blocked out and thoroughly sampled, and under the circumstances the estimate given appears to be a mere leap in the dark. (2) No indication is given as to how this dump tonnage and its average content were arrived at. (3) Only two points on the Unity lode are quoted in Mr. Reed's report as assaying 60 lb. per ton, and one on the Red lode of 55 lb. (4) It is not stated how many pits have been put down to prove the 48 acres, and presumably the figures quoted are based on the results secured by the sluices already in operation. From the report of Mr. H. Bennetts, it appears that 10 sluices are treating 400 tons of alluvium per day, producing 19,250 lb. of tin oxide per week, valued at £1,280. This figures at approximately £150 per ton, which is very low for alluvial tin, bearing in mind the price of the metal. It is also stated that the last sale from the mines was 20 tons of black tin, including 10 tons from alluvial, but here again it is not stated from what tonnage of ore and yardage of alluvial it was returned, or how long it took to return it.

We have gone into this matter at some length because we hold strongly the opinion that statements of the definite character named should be accompanied by data which will justify them; if the estimates fail to materialize much harm will be done to Cornish mining, and will reflect on the industry as a whole. It may be that the properties leased by the company show sufficient promise to justify further exploitation, but certainly the £25,000 available will be insufficient to do the work outlined as desirable in the various reports.

KINGSDOWN (HEWAS WATER) TIN MINES LTD.—This company was registered in August last with a nominal capital of £60,000 in shares of 2s. each, and at the time of writing 200,000 of them (or £20,000) are being offered for public subscription to provide working capital. The purchase price is £35,000, payable wholly in fully-paid shares, but the vendors also have the option on 50,000 at par for a period of two years from registration. This property is situated in the famous St. Austell district, and immediately adjoins on its eastern boundary the Great Hewas mine, which was such a prolific producer in the early eighties, while on the west is the Ventonwyn mine. The mine has been reported on by several well-known engineers, and these reports are stated to be uniformly favourable. From the report of Mr. M. D. Caldwell, Assoc.Inst.M.M., it would appear that some development work —more in the nature of prospecting—has been carried out with encouraging results, while since his report was made, the main shaft has been sunk to a depth of 203 ft., and permanent pitwork is being installed. From this shaft, cross-cuts will be driven to intersect the various lodes. At present all talk of the erection of a mill is premature; indeed we doubt, even if the whole of the working capital is subscribed, whether the money will be sufficient to carry out the programme of development, pay the preliminary expenses, and also provide a mill. This latter, it is proposed, will be of a capacity of 2,000 tons of ore per month. Mr. Caldwell estimates a recovery of 35 lb. tin per ton, and an all-in mining and milling cost of 35s. per ton; on this basis, with tin metal at approximately £240 per ton, he figures a profit of £1,500 per month, or £18,000 per annum. The directors give this latter figure as the net profit, whereas Mr. Caldwell's cost of 35s. per ton excludes royalties, rates and taxes, general administration expenses, and depreciation. Of course, at the time of writing, the higher price of tin would be more than sufficient to offset these charges, so that if a recovery value can be secured of 35 lb. per ton on 24,000 tons per annum, we see no reason to quarrel with the estimated profit, taking tin at its present price. We judge this to be a promising mining venture, and the fact that Messrs. Pawle & Brelick are the consulting engineers of the company, is a guarantee that the capital will be spent to the best advantage.

PERSONAL

A. W. ALLEN has returned to New York from Chile.

L. MAURICE COCKERELL left on January 17 for New York, on his way to visit Canada, Cuba, and Mexico.

LT.-COL. ROWLAND FEILDING, D.S.O., has returned to the City, and has offices at 1, Broad Street Place.

CYRIL W. GUDGEON, manager of the Mount Bischoff Extended, has been appointed general manager of the Mount Bischoff mine, in succession to J. D. Millen.

DR. J. A. L. HENDERSON has moved his office to 108A, Cannon Street, London, E.C.4.

W. INGHAM, chief engineer of the Rand Water Board, has been elected president of the South African Society of Civil Engineers for 1920.

DUDLEY J. INSKIPP has returned from India.

H. C. JENKINS has left for Portugal.

E. S. KING is home from Nigeria.

ALBERT H. LOW, the well-known authority on assaying, has been appointed professor of chemistry in the Colorado School of Mines.

DR. MALCOLM MACLAREN has left for Algeria.

WILLIAM MCNEILL has returned from Mexico.

T. M. OWEN has returned to the United States from Australia, and has been appointed assistant general manager for the Federal Lead Mining & Smelting Co., Idaho.

EDGAR PAM has returned to South Africa.

O. B. PERRY has gone to Ipoh, Perak, in connection with tin-dredging business for the Guggenheims.

HENRY S. POTTER has been awarded the gold medal of the South African Institution of Engineers for his paper on hammer-drills. It is understood that he will shortly be introducing a new hammer-drill to be known as the Pottermax.

W. SELKIRK has moved his office to 4, Broad Street Place, London, E.C.2.

OLIVER THOMPSON is home from Nigeria.

J. B. TYRRELL has left London on his return to Canada.

A. B. WATSON has left England for the Gold Coast.

L. J. WILMOTH has left for Timor.

BENJAMIN HOLLINGER, the discoverer of the gold deposit named after him at Porcupine, died on November 26, at the early age of 34.

W. H. TWELVETREES, Government Geologist for Tasmania for over twenty years, died on November 7, at the age of 71. He was born in England and educated at London and Hamburg. He spent ten years among the Russian copper mines, and another ten at silver-lead mines in Asia Minor. He went to Australia in 1891. His writings on geological and mining subjects were of a high order.

TRADE PARAGRAPHS

BRUCE PEEBLES & CO., LTD., Edinburgh, send us Pamphlet No. 13C, describing their alternating current generators.

LOW & BONAR, LTD., of Dundee, send us a neatly designed perpetual calendar, suitable for the desk or mantelpiece.

MARSHALL, SONS & CO., LTD., Britannia Ironworks, Gainsborough, have moved their London office to 3, London Wall Buildings, E.C.2.

THE MERRILL CO., of San Francisco, send us a large wall calendar for 1920, illustrating the Merco Nordstrom Plug Valve.

THERMIT, LTD., have absorbed the business of the CONTINUOUS REACTION CO., LTD., and have moved their offices to 155, Church Road, Battersea.

THE WORTHINGTON PUMP & MACHINERY CORPORATION, 115, Broadway, New York, send us their wall calendar for 1920.

DRYSDALE & CO., LTD., Yoker, Glasgow, send us their catalogue of "Bon Accord" centrifugal pumps. These pumps have many applications in mining and metallurgy.

HENRY BATH & SON, of London, Liverpool, and Swansea, have issued a chart, giving the fluctuations in the prices of copper, tin, lead, and zinc in graphic form during the years 1908 to 1919 inclusive

JAMES W. CARR & CO., LTD., 35, Queen Victoria Street, London, E.C., have issued a pamphlet giving particulars of machine and other tools required in garage and similar workshops.

THE GENERAL ELECTRIC CO., LTD., Queen Victoria Street, London, E.C., send us a leaflet describing the electrification of a steel-works plant near Birmingham.

SULZER BROTHERS, of Winterthur, Switzerland, and 30, Norfolk Street, London, W.C., send us their catalogue of electrically-driven high-lift centrifugal pumps.

J. & E. WRIGHT, LTD., of the Universe Wire Rope Works, Birmingham, have sent A. W. Parsons, their works foreman, on a tour through Canada to study and advise as to conditions under which ropes are being used on mines, etc.

AGRICULTURAL & GENERAL ENGINEERS, LTD., recently formed for the purpose of controlling Aveling & Porter, E. H. Bentall & Co., Blackstone & Co., Richard Garrett & Sons, and J. & F. Howard, have acquired a building site in Aldwych and are proceeding to erect commodious offices and show-rooms.

THE MARINE WORKS, LTD., of Friars House, New Broad Street, London, E.C., the company representing Werf Conrad, the ship and dredge builders and makers of the Banca drill, of Haarlem, Holland, announce the appointment of Ashurst E. Menzies, A.R.S.M., Assoc.Inst.M.M., as managing director.

VICKERS, LTD., of Broadway, Westminster, commenced the publication of a fortnightly house organ, known as "Vickers News," last year. This firm has so enormous a range of industries within its control that the editor of the "News" has no difficulty in producing highly informative and interesting issues.

THE MARION STEAM SHOVEL CO., of Marion, Ohio (British agents, S. Thornely Mott & Vines, Ltd., 11, Old Queen Street, Westminster), send us their wall calendar. This firm is making a specialty at present of a small revolving digger mounted on a crawler wheel-base, a catalogue of which will be sent to any applicant.

METAL MARKETS

COPPER.—The general sentiment in regard to copper has varied during the past month, and the course of prices has been somewhat irregular. This is evidenced by the fact that while the value of standard copper has improved, that of refined copper has declined. It was generally admitted that previously the difference between the two was too wide, and bearing in mind the fact that the stocks of actual standard copper were fairly small it seemed as if the price of standard was too low, especially when the enhanced price of every other commodity is considered. As things have turned out, matters have been adjusted by an upward movement

DAILY LONDON METAL PRICES: OFFICIAL CLOSING
Copper, Lead, Zinc, and Tin per Long

	COPPER				
	Standard Cash	Standard (3 mos.)	Electrolytic Ingots	Electrolytic Wire-Bars	Best Selected
Jan.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
12	119 10 0 to 120 0 0	122 5 0 to 122 10 0	124 0 0 to 126 0 0	124 0 0 to 126 0 0	123 0 0 to 124 0 0
13	119 15 0 to 120 0 0	122 5 0 to 122 10 0	124 0 0 to 125 0 0	124 0 0 to 125 0 0	124 0 0 to 125 0 0
14	120 5 0 to 120 10 0	122 15 6 to 123 0 0	124 0 0 to 125 0 0	124 0 0 to 125 0 0	124 0 0 to 125 0 0
15	119 15 0 to 120 0 0	122 0 0 to 122 5 0	124 0 0 to 125 0 0	124 0 0 to 125 0 0	124 0 0 to 125 0 0
16	117 15 0 to 118 0 0	120 0 0 to 120 5 0	123 0 0 to 124 0 0	123 0 0 to 124 0 0	123 0 0 to 124 0 0
19	117 15 0 to 118 0 0	119 15 0 to 120 0 0	122 0 0 to 123 0 0	122 0 0 to 123 0 0	123 0 0 to 124 0 0
20	116 5 0 to 116 10 0	118 5 0 to 118 10 0	122 0 0 to 123 0 0	122 0 0 to 123 0 0	121 0 0 to 123 0 0
21	115 10 0 to 115 15 0	117 7 6 to 117 10 0	121 10 0 to 122 10 0	121 10 0 to 122 10 0	121 0 0 to 123 0 0
22	114 15 0 to 115 0 0	116 15 0 to 117 0 0	121 10 0 to 122 0 0	121 10 0 to 122 0 0	121 0 0 to 123 0 0
23	115 0 0 to 115 5 0	116 15 0 to 117 0 0	121 0 0 to 122 0 0	121 0 0 to 122 0 0	121 0 0 to 122 0 0
26	117 15 0 to 118 0 0	119 15 0 to 120 0 0	122 10 0 to 123 10 0	122 10 0 to 123 10 0	121 0 0 to 122 0 0
27	119 10 0 to 119 15 0	121 5 0 to 121 10 0	123 0 0 to 124 0 0	123 0 0 to 124 0 0	123 0 0 to 124 0 0
28	120 5 0 to 120 10 0	122 0 0 to 122 5 0	123 0 0 to 124 0 0	123 0 0 to 124 0 0	123 0 0 to 124 0 0
29	120 0 0 to 120 5 0	121 10 0 to 121 15 0	123 0 0 to 125 0 0	123 0 0 to 125 0 0	123 0 0 to 124 0 0
30	118 17 6 to 119 0 0	120 12 6 to 120 15 0	122 10 0 to 124 10 0	123 0 0 to 125 0 0	122 10 0 to 123 10 0
Feb.					
2	119 10 0 to 119 15 0	121 5 0 to 121 7 6	123 0 0 to 125 0 0	124 0 0 to 125 0 0	122 10 0 to 123 10 0
3	119 0 0 to 119 5 0	120 10 0 to 120 15 0	124 0 0 to 127 0 0	125 0 0 to 127 0 0	123 10 0 to 124 10 0
4	119 0 0 to 119 5 0	120 15 0 to 121 0 0	125 0 0 to 128 0 0	126 0 0 to 128 0 0	123 10 0 to 124 10 0
5	120 15 0 to 121 0 0	122 10 0 to 122 15 0	126 0 0 to 130 0 0	128 0 0 to 130 0 0	123 10 0 to 124 10 0
6	121 5 0 to 121 10 0	123 5 0 to 123 10 0	127 0 0 to 131 0 0	129 0 0 to 131 0 0	126 0 0 to 128 0 0
9	121 15 0 to 121 17 6	123 15 0 to 123 17 6	128 0 0 to 132 0 0	130 0 0 to 132 0 0	126 0 0 to 128 0 0
10	121 10 0 to 121 15 0	123 10 0 to 123 15 0	128 0 0 to 132 0 0	130 0 0 to 132 0 0	127 0 0 to 129 0 0

in standard, partly no doubt due to speculation, and by a decline in the price of refined copper. The reasons for the fall in the latter are not far to seek. Ever since the end of the war an enormous surplus stock of copper has been held in the United States, and this has hung over the market like a cloud. The chief holders now appear to have got tired of carrying the load, and in the effort to liquidate their stocks have cut prices. As soon as the stocks are reduced to more reasonable proportions it seems likely that the big producers will at once stiffen their prices. The feeling indeed already seems a trifle harder, while the low rate of exchange with America further increases the cost to this side. Business with consumers in America has, it is understood, been good, but here it can only be called moderate, the outlet for new copper being possibly reduced by the quantities of scrap available. An excellent inquiry has been in evidence for such manufactured material as sheets, plates, bottoms, etc. The output of copper in Montana decreased from 323,174,850 lb. in 1918 to about 180,246,000 lb. in 1919. It is understood to be probable that the Cerro de Pasco Copper Co. will enter into an agreement with the result that its output will be handled in future by the American Metal Co. The Cerro company is interested in the American Metal Co. The company's output is at present handled by the American Smelting & Refining Co. As regards Africa, the production of the Union Minière for December was 2,156 tons, making a total for the year of 23,004 tons.

Average price of cash standard copper: January 1920, £118. 4s. 1d.; December 1919, £103. 17s. 2d.; January 1919, £93. 9s. 9d.; December 1918, £116. 5s.

TIN.—The feature of this market during the past month has been the further important rise in values which has taken place. This is no doubt due in a great measure to the large amount of speculative interest which has been attracted to this metal. Although that may be so, the intrinsic position appears to be quite sound, as in spite of the great enhancement in values, so far there has been no sign of any increase in the supplies. Indeed the phenomenal price to which silver has risen has a tendency to increase the cost of output in the East. Meanwhile the demand for tinplates has been simply enormous and this must ensure a large demand at home for tin for a long time to come. In addition, a very big outlet is expected in America, and with stocks already small in this country the general situation of the metal can only be called strong. One of the best features of the market has perhaps been the manner in which speculative realizations have been absorbed. Whenever profit-taking sales made their appearance a little reaction was of course caused, but there seemed to be plenty of demand about to take care of the metal which came out. It is interesting to note that the United States imports for the whole of 1919 amounted to 35,404 tons, against 58,027 tons in 1918. The falling off included about 8,000 tons from the Straits, 1,600 tons from Australia, 5,300 tons from Batavia, 2,000 tons from the U.K., and 5,800 tons from China. From all accounts it would appear as if stocks on the Continent were now getting depleted, and it is possible that a good demand will be seen from there.

Average price of cash standard tin: January 1920, £376. 12s. 9d.; December 1919, £314. 5s. 1d.; January 1919, £248. 9s. 11d.; December 1918, £267. 14s. 3d.

LEAD.—This market has advanced still further during the past month, and a very active business has continued to be done on the Metal Exchange. It has been noticeable that some considerable realizations have taken place from time to time, these being re-sales of parcels speculatively held, and in some instances very substantial profits have accrued to the sellers. The metal thus offered, however, was very well absorbed, and it looked at times as if prices would have gone still higher had it not been for this selling. A remarkable feature indeed is that such sales did not materially depress prices, and this says something for the intrinsic position of the metal. There is no particular change as regards supplies, the long drawn-out strike in Australia still continuing, and there does not seem to be much prospect of any early supplies of importance from Spain. Meanwhile consumers have shown a disposition to keep down their purchases to actual necessities, but the general outlook for the consumption of the metal in this country seems good, especially when one considers the building programmes which will surely get started some day. It is estimated by statisticians in America that apart from the United States, Canada, and Mexico the world in the last year produced 170,000

PRICES ON THE LONDON METAL EXCHANGE.
Tons; Silver per Standard Ounce; Gold per Fine Ounce.

Lead: Soft Foreign (£ s. d. to £ s. d.)	Lead: English (£ s. d.)	Zinc (Spelter) (£ s. d. to £ s. d.)	Standard Tin: Cash (£ s. d. to £ s. d.)	Standard Tin: 3 mos. (£ s. d. to £ s. d.)	Silver: Cash	Silver: Forward	Gold (s. d.)	
								Jan.
47 10 0 to 48 2 6	49 0 0	59 5 0 to 61 5 0	378 0 0 to 378 5 0	380 15 0 to 381 [illegible] 0	[illegible]	79⅛	[illegible]	[illegible]
47 0 0 to 47 15 0	49 0 0	58 15 0 to 60 10 0	379 10 0 to 379 15 0	381 10 0 to 381 15 0	82¼	79⅝	110 0	13
47 0 0 to 47 15 0	48 10 0	57 15 0 to 59 10 0	377 15 0 to 378 0 0	380 5 0 to 380 10 0	81½	[illegible]	110 0	14
47 5 0 to 47 12 6	48 10 0	58 5 0 to 60 5 0	371 10 0 to 371 15 0	372 10 0 to 372 15 0	[illegible]	75½	110 8	15
47 7 6 to 47 15 0	48 10 0	58 15 0 to 60 10 0	376 5 0 to 376 10 0	377 10 0 to 377 15 0	77	[illegible]	111 [illegible]	16
47 12 6 to 47 17 6	48 10 0	58 10 0 to 60 5 0	384 10 0 to 384 15 0	386 5 0 to 386 10 0	79	[illegible]	111 3	[illegible]
47 5 6 to 47 15 0	48 5 0	58 0 0 to 60 0 0	384 0 0 to 384 5 0	386 0 0 to 386 5 0	[illegible]	[illegible]	111 10	[illegible]
46 10 0 to 46 15 0	47 10 0	58 0 0 to 59 15 0	384 0 0 to 384 5 0	385 5 0 to 385 10 0	[illegible]	[illegible]	113 0	21
46 15 0 to 47 0 0	47 15 0	58 0 0 to 59 15 0	384 15 0 to 385 0 0	386 0 0 to 386 5 0	[illegible]	[illegible]	114 6	22
46 12 6 to 47 0 0	47 15 0	58 5 0 to 60 5 0	387 5 0 to 387 10 0	387 15 0 to 388 0 0	[illegible]	78¾	113 6	23
46 5 0 to 47 0 0	47 10 0	58 5 0 to 60 10 0	389 5 0 to 389 10 0	388 15 0 to 389 0 0	81¼	[illegible]	116 0	[illegible]
46 10 0 to 47 5 0	47 15 0	59 0 0 to 61 0 0	389 10 0 to 390 0 0	[illegible] 15 0 to 389 0 0	[illegible]	81	116 6	[illegible]
46 15 0 to 47 7 6	47 15 0	59 5 0 to 61 0 0	388 10 0 to 389 0 0	388 10 0 to 388 15 0	84½	[illegible]	117 6	28
47 5 0 to 47 15 0	48 5 0	59 0 0 to 60 15 0	383 15 0 to 384 0 0	383 15 0 to 384 0 0	85	84	117 6	[illegible]
47 5 0 to 47 15 0	48 5 0	59 10 0 to 61 0 0	383 5 0 to 384 0 0	383 10 0 to 384 0 0	[illegible]	83½	117 0	30
								Feb.
47 10 0 to 48 0 0	48 10 0	59 17 6 to 61 17 6	383 15 0 to 384 0 0	384 5 0 to 384 10 0	84⅜	83½	117 6	2
47 15 0 to 48 5 0	48 15 0	60 0 0 to 62 0 0	386 5 0 to 386 10 0	386 10 0 to 386 15 0	85	85	120 10	3
48 0 0 to 48 10 0	49 0 0	60 10 0 to 62 10 0	388 10 0 to 388 15 0	388 15 0 to 389 0 0	[illegible]	[illegible]	125 9	4
48 7 6 to 48 17 6	49 0 0	61 2 6 to 62 12 6	390 0 0 to 390 10 0	390 10 0 to 390 15 0	[illegible]	85⅝	127 4	5
48 15 0 to 49 5 0	49 15 0	61 10 0 to 63 5 0	391 10 0 to 392 0 0	392 5 0 to 392 10 0	88	86¼	123 6	6
49 2 6 to 49 17 6	50 5 0	60 0 0 to 63 10 0	392 10 0 to 392 15 0	392 15 0 to 393 0 0	[illegible]	86½	123 6	9
49 7 6 to 50 0 0	50 10 0	62 0 0 to 64 0 0	392 15 0 to 393 5 0	393 10 0 to 393 15 0	88¾	87½	[illegible] 0	10

tons of lead less than in 1918. The United States is officially reported to have yielded in 1919 100,000 short tons less than in 1918.

Average price of soft pig lead: January 1920, £47. 7s. 2d.; December 1919, £41. 7s. 8d.; January 1919, £34. 10s.; December 1918, £40.

SPELTER.—This article has also advanced in price recently, and a good deal of interest has been taken in the metal on 'Change. There is no doubt that much of this has been for speculative account, but nevertheless the general position seems quite good. Reactions appeared from time to time as profit-taking sales took place, but as a general rule the metal was well absorbed by dealers, and values soon reacted again upwards. The demand from consuming trades has been on the whole very satisfactory, and should continue so in view of the active demand for galvanized products. Meanwhile it would appear that this country must continue to draw almost all its supplies from America, and the market in that country has been firm, due, it must be admitted, chiefly to the buying by dealers and consumers here. Latterly, however, users in the United States seem also to have been taking more interest in the market. It is anticipated that production in 1919 will show a falling off except in so far as re-melted is concerned. In the United States a decrease in output has taken place, while on the Continent, although some works have been producing, most of them are still reconstructing. In this country a falling off will be seen due in part to shortage of ore, transport difficulties, and lack of labour.

Average price of spelter: January 1920, £59. 10s. 4d.; December 1919, £53. 9s. 3d.; January 1919, £50. 15s. 11d.; December 1918, £54.

ZINC DUST.—This market has remained firm, but with no material change in price, high-grade imported material standing at about £85 per ton.

ANTIMONY.—This article has considerably advanced in value during the period under review, the price of English regulus now being quoted at £69 per ton, while for foreign material about £66 per ton is asked.

ARSENIC.—The market is very quiet but firm, and the price stands at £68 to £70 per ton for white delivered London.

BISMUTH.—A very good business has been doing, but the price remains at about 12s. 6d. per lb.

CADMIUM.—Firmer at 6s. 6d. to 6s. 9d. per lb.

ALUMINIUM.—£165 is quoted now for the home trade, while for export a premium is demanded. It is reported that the Government stocks are now all sold.

NICKEL.—This metal has been advanced to £220 per ton for the home trade, and £225 per ton for export.

COBALT METAL.—10s. 6d. per lb.

COBALT OXIDE.—8s. 3d. per lb.

PLATINUM.—770s. nominal per oz.

PALLADIUM.—800s. nominal per oz.

QUICKSILVER.—The market declined to £22 to £22. 10s. per bottle in January, and early in February eased off to £21. 10s. to £21. 15s.

SELENIUM.—Lower at 10s. to 11s. per lb.

TELLURIUM.—95s. to 100s. per lb.

SULPHATE OF COPPER.—Higher at about £50 per ton.

MANGANESE ORES.—3s. 6d. and upwards per unit c.i.f. U.K.

TUNGSTEN ORES.—The Government stocks are reported to have been sold to British users at 29s. Holders here now ask about 34s. to 35s. (in warehouse) per unit.

MOLYBDENITE.—85%, 55s. per unit.

SILVER.—The market has been strong, and has touched new high records, the price of spot standard bars on January 29 being 85d. per oz. At the end of that month, the value had eased off to 83d., but early in February the price advanced to 89d.

GRAPHITE.—80%, £35 to £40 per ton c.i.f. U.K.

CHROME ORES.—48 to 50%, £8 per ton.

IRON & STEEL.—The feature of these markets has been the general advance in prices consequent upon the rise in railway rates. For No. 1 Cleveland 182s. 6d. and for No. 3 175s. are now quoted for the home trade, with an export premium of 5s. per ton for France, Italy, and Belgium. For other foreign destinations the price is open to negotiation, and much higher prices have been obtained. The moulders strike is now happily at an end, and this will undoubtedly further augment the enormous demand for all classes of pig iron. As regards steel the demand is overwhelming both for home and export, and prices are very firm.

STATISTICS.

PRODUCTION OF GOLD IN THE TRANSVAAL. Par Values.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1918	8,197,959	221,734	8,419,693	35,768,688
January, 1919	662,205	13,854	676,059	2,871,718
February	621,188	15,540	636,728	2,704,647
March	694,825	17,554	712,379	3,025,992
April	676,702	18,242	694,944	2,951,936
May	706,158	18,837	724,995	3,079,583
June	682,603	19,776	702,379	2,983,515
July	705,523	19,974	725,497	3,081,713
August	686,717	19,952	706,669	3,001,739
September	680,359	18,199	698,558	2,967,287
October	705,313	18,409	723,722	3,074,174
November	657,845	20,125	677,920	2,879,834
December	631,833	18,358	650,191	2,761,836
Year 1919	8,111,271	218,820	8,330,091	35,383,974

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold mines	Coal mines	Diamond mines	Total
October 31, 1918	173,153	11,824	4,749	189,726
November 30	160,275	11,826	4,016	176,117
December 31	152,606	11,851	3,180	167,637
January 31, 1919	160,599	11,848	3,539	175,986
February 28	172,359	11,868	4,264	188,491
March 31	175,620	11,168	5,080	191,868
April 30	175,267	11,906	5,742	192,915
May 31	173,376	12,232	5,939	191,547
June 30	172,505	12,544	5,831	190,880
July 31	173,613	12,453	5,736	191,802
August 31	170,844	12,450	5,655	188,949
September 30	169,120	12,392	5,294	186,806
October 31	167,499	12,691	4,492	184,682
November 30	164,671	12,565	4,337	181,573
December 31	166,155	12,750	4,271	183,176

COST AND PROFIT ON THE RAND.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 65% of the working profit. Figures based on par value of gold.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
October, 1918	2,015,144	28 0	22 5	5 3	531,774
November	1,899,925	28 5	23 1	5 1	480,102
December	1,855,991	28 7	23 0	5 6	507,860
Year 1918	24,922,763	27 11	21 7	6 0	7,678,129
January, 1919	1,942,329	28 9	23 0	5 8	547,793
February	1,816,352	28 9	23 2	5 6	498,204
March	2,082,469	28 2	22 6	5 6	573,582
April	1,993,652	28 7	22 9	5 9	573,143
May	2,099,450	28 4	22 3	5 10	608,715
June	2,032,169	28 4	22 4	5 10	592,361
July	2,134,668	27 10	21 9	6 0	611,118
August	2,036,428	28 5	22 11	5 5	551,203
September	2,019,109	28 6	22 10	5 7	560,979
October	2,108,698	28 3	22 6	5 10	612,841
November	1,933,526	28 8	23 5	5 5	521,472

PRODUCTION OF GOLD IN RHODESIA AND WEST AFRICA. Par Values.

	Rhodesia.		West Africa.	
	1918	1919	1918	1919
	£	£	£	£
January	253,807	211,917	107,863	104,063
February	232,023	220,885	112,865	112,616
March	230,023	225,808	112,605	112,543
April	239,916	213,160	117,520	109,570
May	239,205	218,057	126,290	100,827
June	225,447	214,215	120,273	106,612
July	251,740	214,919	117,581	102,467
August	257,096	207,339	120,526	103,112
September	247,885	223,719	115,152	100,401
October	136,780	204,184	61,461	91,352
November	145,460	186,462	108,796	98,322
December	192,870	158,835	112,621	—
Total	2,652,250	2,499,498	1,333,553	1,141,885

TRANSVAAL GOLD OUTPUTS.—Par Values.

	November, 1919		December, 1919	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Aurora West	13,000	14,321	14,000	14,371
Bantjes	—	—	—	—
Barrett	—	210	—	—
Brakpan	44,000	82,188	44,100	87,416
City & Suburban	18,496	28,331	18,318	28,386
City Deep	54,000	101,003	54,000	98,517
Cons. Langlaagte	36,500	49,572	35,100	48,781
Cons. Main Reef	44,000	69,342	41,000	70,324
Crown Mines	163,000	233,021	155,000	218,743
Durban Roodepoort Deep	20,700	28,585	19,800	27,300
East Rand P.M.	126,000	151,112	112,000	152,824
Ferreira Deep	30,400	45,646	31,000	42,618
Geduld	44,200	68,139	43,500	67,571
Geldenhuis Deep	44,100	51,977	44,000	52,998
Ginsberg	—	—	—	—
Glynn's Lydenburg	3,548	6,948	2,930	4,689
Goch	13,100	11,050	13,500	11,949
Government G.M. Areas	109,000	199,301	103,000	194,591
Heriot	10,620	14,255	10,580	13,145
Jupiter	23,200	26,700	11,300	15,446
Kleinfontein	50,000	66,998	49,000	67,830
Knights Central	21,000	28,542	19,000	28,802
Knights Deep	82,600	61,811	80,900	59,358
Langlaagte Estate	32,600	42,156	33,670	38,879
Luipaard's Vlei	15,810	15,120	14,300	13,741
Meyer & Charlton	13,000	37,006	12,500	37,165
Modderfontein	77,000	173,868	75,600	173,992
Modderfontein B	50,000	114,072	51,000	104,077
Modderfontein Deep	40,700	93,872	41,100	98,083
New Unified	9,600	11,107	10,500	11,579
Nourse	38,000	48,744	37,700	50,912
Primrose	15,000	15,905	15,000	15,900
Princess Estate	17,800	22,245	16,700	19,782
Randfontein Central	135,700	155,150	133,500	153,326
Robinson	41,000	40,281	38,900	41,123
Robinson Deep	50,200	74,548	46,900	72,117
Roodepoort United	20,800	20,490	21,200	21,377
Rose Deep	44,700	51,805	45,000	50,805
Simmer & Jack	47,100	52,433	43,500	50,219
Simmer Deep	45,800	46,337	21,800	27,456
Springs	36,200	71,902	35,000	67,877
Sub Nigel	8,900	23,689	8,200	24,332
Transvaal G.M. Estates	15,540	25,640	15,710	25,719
Van Ryn	31,100	31,567	31,700	31,362
Van Ryn Deep	46,500	56,553	47,300	108,163
Village Deep	44,900	60,288	42,200	57,514
Village Main Reef	17,953	22,770	20,000	24,150
West Rand Consolidated	29,000	35,100	28,170	32,514
Witwatersrand (Knights)	31,800	36,567	29,550	35,459
Witwatersrand Deep	26,400	37,214	27,300	39,350
Wolhuter	27,000	35,965	25,000	35,099

* Fine Ounces.

WEST AFRICAN GOLD OUTPUTS.—Par Values.

	November, 1919		December, 1919	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Abbontiakoon	7,400	17,882	6,701	18,117
Abosso	7,300	12,536	7,320	12,571
Ashanti Goldfields	6,445	29,735	7,152	31,120
Offin River	—	—	—	—
Prestea Block A	14,638	23,924	13,312	22,332
Taquah	4,803	12,744	4,977	12,807
Wassau	—	—	—	—

RHODESIAN GOLD OUTPUTS.—Par Values.

	November, 1919		December, 1919	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Antelope	—	—	—	—
Cam & Motor	18,496	28,331	—	—
Eldorado Banket	—	—	—	—
Falcon	14,020	23,730*	7,434	3,757*
Gaika	3,118	5,435	1,554	3,636
Globe & Phœnix	4,922	5,889†	5,110	5,849†
Lonely Reef	4,480	24,995	4,600	6,036†
Rezende	5,100	12,168	4,900	8,720
Rhodesia, Ltd.	783	340	754	382
Rhodesia, G.M. & I.	1,069	2,600‡	570	324
Shamva	50,867	38,371	24,246	13,953
Transvaal & Rhodesian	1,750	4,250	1,800	4,294
Wanderer	—	—	—	—

*Gold, Silver and Copper; † Ounces Gold; ‡ Oct. and Nov.

West Australian Gold Statistics.—Par Values.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
January, 1919	*	69,954	*	*
February	733	66,310	67,043	284,779
March	*nil*	66,158	66,158	281,120
April	33	63,465	63,498	269,720
May	525	68,655	69,180	293,856
June	1,050	73,546	74,596	316,862
July	680	68,028	68,708	292,852
August	835	58,117	58,952	250,410
September	†	†	†	†
October	586	64,987	65,573	278,535
November	1,171	64,823	65,994	280,323
December	831	27,334	28,165	162,575
January, 1920	836	25,670	26,506	112,590

* By direction of the Federal Government the export figures were not published. † Figures not received.

Australian Gold Returns.—Par Values.

	Victoria.		Queensland.		New South Wales	
	1918	1919	1918	1919	1918	1919
	£	£	£	£	£	£
January	32,134	36,238	47,600	37,100	25,000	18,000
February	58,113	46,955	45,470	43,330	28,000	24,000
March	65,412	40,267	48,020	48,000	30,000	16,000
April	29,620	63,818	47,600	61,200	30,000	24,000
May	87,885	37,456	46,740	38,200	45,000	16,000
June	45,765	41,465	51,420	44,600	32,000	17,000
July	64,347	37,395	51,000	42,060	25,000	22,000
August	61,163	51,564	44,600	49,700	21,000	20,000
September	65,751	76,340	45,900	37,120	32,000	13,000
October	*	39,018	54,400	36,100	40,000	28,000
November	*	40,725	38,200	32,720	25,000	51,000
December	70,674	63,311	56,281	44,500	38,000	31,000
Total	674,655	575,260	578,213	514,630	370,000	280,000

* Figures not received.

Australasian Gold Outputs.—Par Values.

	November, 1919		December, 1919	
	Treated Tons	Value £	Treated Tons	Value £
Associated	—	—	—	—
Associated Northern Blocks :				
Iron Duke	—	139*	—	—
Victorious	—	240*	—	597
Blackwater	2,121	4,376	1,627	3,083
Bullfinch	5,600	4,480	5,100	4,846
Golden Horseshoe	—	—	—	—
Great Boulder Prop.	1,129	3,617	—	—
Ivanhoe	—	—	—	—
Kalgurli	—	—	—	—
Lake View & Star	—	—	—	—
Mount Boppy	—	—	2,815	3,680
Oroya Links	—	—	—	218†
Progress	1,240	1,901	1,050	1,790
Sons of Gwalia	11,288	16,704	11,042	15,968
South Kalgurli	—	—	—	—
Talisman	—	—	—	—
Waihi	16,265	27,422‡	13,373	19,128‡
Waihi Grand Junction	5,530	8,015§	4,400	6,606§

* Surplus ; † Total receipts ; ‡ Oz. Gold and Silver ; § Gold and Silver.

Miscellaneous Gold Outputs.—Par Values.

	November, 1919		December, 1919	
	Treated Tons	Value £	Treated Tons	Value £
Barramia (Sudan)	—	—	—	—
Esperanza (Mexico)	16,871	1,060‡	—	—
Frontino & Bolivia (C'lbia)	2,810	9,851	2,570	10,743
Nechi (Colombia)	276,616*	53,400†	84,678*	39,559†
Ouro Preto (Brazil)	7,200	13,280	7,200	14,000
Pato (Colombia)	81,413*	25,342†	219,789*	21,252†
Philippine Dredges (P.I.)	—	—	—	—
Plymouth Cons. (Calif'rnia)	9,000	12,082	9,300	12,069
St. John del Rey (Brazil)	—	33,000	—	35,000
Santa Gertrudis (Mexico)	26,890	34,390‡	29,330	39,680‡
Sudan Gold Field (Sudan)	—	—	—	—

* Cubic yards. † Dollars. ‡ Profit, gold and silver.

Production of Gold in India.—Par Value.

	1916	1917	1918	1919
	£	£	£	£
January	[illegible]	190,947	176,030	[illegible]
February	183,264	[illegible]	175,343	[illegible]
March	186,475	[illegible]	177,950	[illegible]
April	192,208	[illegible]	176,486	[illegible]
May	193,604	[illegible]	175,775	[illegible]
June	192,469	[illegible]	174,475	[illegible]
July	191,404	179,660	171,950	[illegible]
August	192,784	181,005	[illegible]	[illegible]
September	192,330	183,630	[illegible]	[illegible]
October	191,502	182,924	167,740	[illegible]
November	192,298	182,188	157,176	[illegible]
December	205,164	190,852	[illegible]	[illegible]
Total	2,305,652	2,214,163	2,061,920	[illegible]

Indian Gold Outputs.

	November, 1919		December, 1919	
	Tons Treated	Fine Ounces	Tons Treated	Fine Ounces
Balaghat	3,200	2,065	3,250	2,328
Champion Reef	11,842	6,860	12,480	6,865
Hutti (Nizam's)	—	450	—	—
Mysore	20,425	15,366	20,113	16,300
North Anantapur	700	1,076	700	1,078
Nundydroog	8,189	6,256	8,662	6,886
Ooregum	12,800	7,555	12,900	9,186

Base Metal Outputs

		Nov. 1919	Dec. 1919
Arizona Copper	Short tons copper	1,450	1,450
British Broken Hill	Tons lead conc.	—	—
	Tons zinc conc.	—	—
	Tons carbonate ore	—	—
Broken Hill Block 10	Tons lead conc.	—	—
	Tons zinc conc.	—	
Burma Corp.	Tons refined lead	1,531	1,647
	Oz. refined silver	181,540	187,350
Cordoba Copper			—
Fremantle Trading	Long tons lead	—	—
North Broken Hill	Tons lead	—	—
	Oz. silver	—	—
Poderosa	Tons copper ore	450	527
Rhodesian Broken Hill	Tons lead	1,050	1,202
Tanganyika	Long tons copper	2,516	2,156
Tolima	Tons silver-lead conc.	65	—
Zinc Corp.	Tons zinc conc.	—	—
	Tons lead conc.		

Imports of Ores, Metals, etc., into United Kingdom.

		Dec. 1919	Year 1919
Iron Ore	Tons	366,956	5,202,707
Manganese Ore	Tons	10,485	265,800
Copper and Iron Pyrites	Tons	32,705	344,457
Copper Ore	Tons	1,163	13,587
Copper Matte and Precipitate	Tons	3,734	17,337
Copper Metal	Tons	8,429	115,012
Tin Concentrate	Tons	2,495	35,737
Tin Metal	Tons	1,379	22,902
Lead, Pig and Sheet	Tons	12,496	217,610
Zinc (Spelter)	Tons	6,331	94,226
Quicksilver	Lb.	233,174	2,841,893
Zinc Oxide	Cwt.	12,381	132,705
White Lead	Cwt.	24,726	140,754
Barytes	Cwt.	30,979	409,418
Phosphate	Tons	43,145	351,817
Brimstone	Cwt.	13,492	151,470
Boracic Compounds	Cwt.	51,675	325,826
Petroleum :			
Crude	Gallons	—	7,577,549
Lamp Oils	Gallons	10,362,255	153,371,858
Motor Spirit	Gallons	12,968,607	200,332,648
Lubricating Oils	Gallons	8,004,000	65,832,998
Gas Oil	Gallons	4,228,683	30,033,002
Fuel Oil	Gallons	24,504,747	265,405,203
Total Petroleum	Gallons	60,068,292	723,026 780

United States Metal Exports and Imports.

Exports.	Sept. Tons.	Oct. Tons.	Imports.	Sept. Tons.	Oct. Tons.
Copper Ingots	27,831	19,643	Antimony......	175	1,083
Copper Tubes	286	350	Tin Con.	4,036	2,366
Copper Sheets	137	311	Tin ..,............	4,949	7,237
Copper Wire.	1,126	1,835	Manganese Ore	19,601	15,863
Lead, Pig	4,194	3,721	TungstenCon	818	592
Zinc	9,161	9,650	Pyrites	28,658	67,15
Zinc Sheets	1,532	1,231			

Outputs of Tin Mining Companies.
In Tons of Concentrate.

	Nov. 1919 Tons	Dec. 1919 Tons	Year 1919 Tons
Nigeria:			
Abu....................................	–	–	16
Anglo-Continental	–	–	117
Associated Nigerian	35	30	185
Benue	4	4	71
Berrida	–	–	1
Bisichi................................	20	11	199
Bongwelli	3	3	52
Dua	5	4	65
Ex-Lands	30	30	260
Filani	–	–	25
Forum River............................	13	13	169
Gold Coast Consolidated................	2	2	33
Gurum River............................	12	15	118
Jantar	14	13	118
Jos	10	10	193
Kaduna	16	18	189
Kaduna Prospectors	7	7	72
Kano	8	8	142
Kassa-Ropp	–	–	84
Kefti..................................	–	–	30
Kuru	18	17	266
Kuskie.................................	2	1	13
Kwall	9	9	56
Lower Bisichi	7	7	78
Lucky Chance	1	1	27
Minna	–	2	38
Mongu	45	60	552
Naraguta	40	35	428
Naraguta Extended	27	20	276
New Lafon	–	–	125
Nigerian Tin...........................	–	–	25
Ninghi.................................	7	11	64
N.N. Bauchi............................	42	36	402
Offin River............................	–	–	50
Rayfield	45	45	618
Ropp	79	71	1,034
Rukuba	6	5	52
South Bukeru	10	10	64
Sybu	1	1	27
Tin Areas	2	–	67
Tin Fields.............................	6	5	148
Toro...................................	–	–	3
Union & Rhodesian Trust	–	–	6
Federated Malay States:			
Chenderiang............................	–	67	264
Gopeng	60	72	797
Idris Hydraulic	27	30	244
Ipoh...................................	18	16	169
Kamunting	–	74	242
Kinta	36	30	438
Kledang	–	–	10
Lahat	44	46	463
Malayan Tin............................	33	44	605
Pahang	186	185	2,180
Rambutan	21	21	180
Sungei Besi	33	58	413
Tekka	42	39	458
Tekka-Taiping..........................	23	25	314
Tronoh	112	69	1,409
Tronoh South	-	–	–
Cornwall:			
Dolcoath	–	–	554
East Pool	77	81	991
Geevor	–	–	186
South Crofty	51	44	590
Other Countries:			
Aramayo Francke (Bolivia).........	148	176	2,255
Briseis (Tasmania).....................	3	4	190
Deebook (Siam)	32	32	306
Mawchi (Burma).........................	60	82	760
Porco (Bolivia)........................	28	23	283
Renong (Siam)..........................	59	56	829
Rooiberg Minerals (Transvaal)...	13	6	241
Siamese Tin (Siam)	96	96	743
Tongkah Harbour (Siam)	150	89	1,244
Zaaiplaats (Transvaal)	15	15	278

Nigerian Tin Production.

In long tons of concentrate of unspecified content.
Note These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1914 Tons	1915 Tons	1916 Tons	1917 Tons	1918 Tons	1919 Tons
January	485	417	531	667	678	613
February ...	469	358	528	646	668	623
March	502	418	547	655	707	606
April	482	444	486	555	584	546
May............	480	357	536	509	525	483
June	460	373	510	473	492	484
July	432	455	506	479	545	481
August.........	228	438	498	551	571	616
September	289	442	535	538	520	561
October	272	511	584	578	491	625
November ...	283	467	679	621	472	530
December ...	326	533	654	655	518	504
Total ...	4,708	5,213	6,594	6,927	6,771	6,672

Total Sales of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
September 9, 1918 ...	142½	£28,793	£202 1 2
September 24..........	145¾	£29,639	£203 7 2
October 7..............	136½	£27,037	£197 14 3
October 21	150	£29,672	£197 16 4
November 4............	141¼	£27,636	£195 13 1
November 18	150	£27,592	£183 19 9
December 2	166¾	£25,170	£150 19 0
December 16	175½	£26,032	£148 6 7
December 30	152	£19,539	£128 11 1
Total and Average, 1918.....................	4,094	£786,541	£192 0 0
January 13, 1919......	160	£20,838	£130 11 0
January 27	135½	£17,000	£125 10 7
February 10	153	£17,441	£113 19 10
February 24............	142	£15,015	£105 14 10
March 10	144½	£18,123	£125 8 5
March 24	148½	£17,877	£120 7 8
April 7	134½	£15,258	£111 8 10
April 22	134¼	£15,023	£111 18 1
May 5	129	£14,919	£115 13 2
May 19	126½	£15,844	£125 5 0
June 2..................	140	£17,185	£122 15 0
June 16.................	139	£17,206	£123 15 9
June 30.................	136	£16,782	£123 8 0
July 14	145	£18,250	£125 17 3
July 28	122	£16,939	£138 16 11
August 11..............	127½	£17,125	£134 6 5
August 25..............	130½	£18,297	£140 4 3
September 8	115½	£16,588	£143 12 6
September 22	135½	£19,557	£144 6 9
October 8	72	£10,867	£150 18 7
October 20	32	£5,093	£159 3 2
November 3............	34½	£5,235	£151 15 0
November 17	39	£6,161	£157 19 9
December 1	38	£5,905	£155 8 3
December 15	29	£5,133	£176 10 0
December 31	14¾	£2,884	£195 10 10
Total and Average, 1919.....................	2,858	£366,569	£128 5 0
January 12, 1920......	31	£6,243	£201 8 0
January 26	51¾	£10,574	£204 6 10
February 9	37½	£7,880	£210 2 5

Details of Redruth Tin Ticketings.

	January 12		January 26	
	Tons Sold	Realized per ton £ s. d.	Tons Sold	Realized per ton £ s. d.
Grenville Utd., No. 1	5	203 0 0	8	215 15 0
,, ,, No. 1a	5	203 0 0	8	212 15 0
,, ,, No, 2	–	—	2½	91 15 0
Tincroft Mines, No. 1	5	212 10 0	5	225 0 0
,, ,, No. 1a	5	212 10 0	5½	220 0 0
Trencrom......................	1	193 7 6	–	—
Penryn Minerals	10	189 10 0	10	200 0 0
,, ,, ...	–	—	5½	201 15 0
,, ,, ...	–	—	2¼	209 5 0
,, ,, ...	–	--	5	200 7 6
Total......	31		51¾	

PRODUCTION OF TIN IN FEDERATED MALAY STATES.
Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1915	1916	1917	1918	1919
	Tons	Tons	Tons	Tons	Tons
January	4,395	4,316	3,558	3,149	3,765
February	3,780	3,372	2,755	3,191	2,673
March	3,653	3,696	3,286	2,608	2,819
April	3,619	3,177	3,251	3,308	2,855
May	3,823	3,729	3,413	3,332	3,404
June	4,048	3,435	3,489	2,950	2,873
July	3,544	3,517	3,253	3,373	3,756
August	4,046	3,732	3,413	3,259	2,955
September	3,932	3,636	3,154	3,166	3,161
October	3,797	3,681	3,436	2,870	3,221
November	4,059	3,635	3,300	3,131	2,972
December	4,071	3,945	3,525	3,023	2,413
	46,767	43,871	39,833	37,370	36,867

STOCKS OF TIN
Reported by A. Strauss & Co. Long Tons.

	Dec. 31, 1919	Jan. 31, 1920
	Tons	Tons
Straits and Australian Spot	1,000	227
Ditto, Landing and in Transit	800	1,370
Other Standard, Spot and Landing	1,658	1,657
Straits, Afloat	2,515	2,635
Australian, Afloat	213	248
Banca, in Holland	2,225	2,610
Ditto, Afloat	1,632	854
Billiton, Spot	—	—
Billiton, Afloat	267	132
Straits, Spot in Holland and Hamburg	—	—
Ditto, Afloat to Continent	77	150
Total Afloat for United States	7,666	7,374
Stock in America	3,438	3,723
Total	21,491	20,980

SHIPMENTS, IMPORTS, SUPPLY, AND CONSUMPTION OF TIN.
Reported by A. Strauss & Co. Long tons.

	Dec. 1919	Jan. 1920
	Tons	Tons
Shipments from:		
Straits to U.K.	2,340	1,340
Straits to America	4,260	2,420
Straits to Continent	77	150
Straits to Other Places	501	330
Australia to U.K.	450	250
U.K. to America	919	650
Imports of Bolivian Tin into Europe	961	1,726
Supply:		
Straits	6,677	3,910
Australian	450	250
Billiton	267	—
Banca	2,972	1,200*
Standard	880	454
Total	11,246	5,814
Consumption:		
U.K. Deliveries	1,686	1,466
Dutch ,,	654	762
American ,,	6,965	3,910
Straits, Banca & Billiton, Continental Ports, etc.	35	187
Total	9,340	6,325

* Estimated.

PRICES OF CHEMICALS. February 9.

		£	s.	d.
Alum	per ton	16	10	0
Alumina, Sulphate of	,,	16	10	0
Ammonia, Anhydrous	per lb.		2	0
,, 0·880 solution	per ton	37	0	0
,, Carbonate	per lb.			7½
,, Chloride of, grey	per ton	48	0	0
,, ,, ,, pure	per cwt.	4	15	0
,, Nitrate of	per ton	60	0	0
,, Phosphate of	,,	110	0	0
,, Sulphate of	,,	22	0	0
Antimony Sulphide	per lb.		1	3
Arsenic, White	per ton	71	0	0
Barium Sulphate	,,	12	0	0
Bisulphide of Carbon	,,	56	0	0
Bleaching Powder, 35% Cl.	,,	17	0	0
Borax	,,	41	0	0
Copper, Sulphate of	,,	50	0	0
Cyanide of Sodium, 100%	per lb.			11
Hydrofluoric Acid	,,			7
Iodine	,,		16	0
Iron, Sulphate of	per ton	4	10	0
Lead, Acetate of, white	,,	90	0	0
,, Nitrate of	,,	65	0	0
,, Oxide of, Litharge	,,	66	0	0
,, White	,,	60	0	0
Lime, Acetate, brown	,,	18	0	0
,, ,, grey 80%	,,	30	0	0
Magnesite, Calcined	,,	22	0	0
Magnesium Chloride	,,	16	0	0
,, Sulphate	,,	12	0	0
Methylated Spirit 64° Industrial	per gal.		5	7
Phosphoric Acid	per lb.		1	9
Potassium Bichromate	,,		1	4
,, Carbonate	per ton	100	0	0
,, Chlorate	per lb.		1	1
,, Chloride 80%	per ton	25	0	0
,, Hydrate (Caustic) 90%	,,	115	0	0
,, Nitrate	,,	60	0	0
,, Permanganate	per lb.		3	6
,, Prussiate, Yellow	,,		2	1
,, Sulphate, 90%	per ton	25	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	56	0	0
,, Arsenate 45%	,,	60	0	0
,, Bicarbonate	,,	8	10	0
,, Bichromate	per lb.			9
,, Carbonate (Soda Ash)	per ton	16	0	0
,, ,, (Crystals)	,,	5	10	0
,, Chlorate	per lb.			6
,, Hydrate, 76%	per ton	24	0	0
,, Hyposulphite	,,	19	0	0
,, Nitrate, 95%	,,	23	0	0
,, Phosphate	,,	34	0	0
,, Prussiate	per lb.		1	7
,, Silicate	per ton	12	0	0
,, Sulphate (Salt-cake)	,,	3	10	0
,, ,, (Glauber's Salts)	,,	4	0	0
,, Sulphide	,,	33	0	0
Sulphur, Roll	,,	22	0	0
,, Flowers	,,	22	0	0
Sulphuric Acid, Non-Arsenical 140°T.	,,	5	0	0
,, ,, ,, 90%	,,	7	5	3
,, ,, ,, 96%	,,	9	7	6
Superphosphate of Lime, 18%	,,	5	0	0
Tartaric Acid	per lb.		3	5
Zinc Chloride	per ton	27	0	0
Zinc Sulphate	,,	22	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	Feb. 7 1919 £	s.	d.	Feb. 6 1920 £	s.	d.
RAND:						
Brakpan	3	17	6	4	5	0
Central Mining (£8)	7	15	0	12	5	0
City & Suburban (£4)		12	6		9	6
City Deep	2	17	0	3	17	6
Consolidated Gold Fields	1	15	0	2	7	6
Consolidated Langlaagte		19	6	1	10	0
Consolidated Main Reef		14	6		17	0
Consolidated Mines Selection (10s.)	1	8	0	1	14	6
Crown Mines (10s.)	2	8	9	4	7	6
Daggafontein	1	10	9	1	2	3
Durban Roodepoort Deep		8	9		10	0
East Rand Proprietary		6	9		14	6
Ferreira Deep		13	9		13	6
Geduld	2	7	6	3	2	6
Geldenhuis Deep		13	9		16	6
Gov't Gold Mining Areas	4	19	6	5	8	9
Heriot	1	0	0		12	6
Johannesburg Consolidated	1	6	0	1	18	0
Jupiter		4	3		7	9
Kleinfontein		14	6		18	0
Knight Central		5	6		7	6
Knights Deep		8	6		13	3
Langlaagte Estate	1	1	3	1	3	6
Meyer & Charlton	5	0	0	5	15	0
Modderfontein (10s.)	28	0	0	4	17	6*
Modderfontein B	8	1	3	9	2	6
Modder Deep (5s.)	7	16	3	3	1	3†
Modder East	—			1	11	3
Nourse		16	3		17	3
Rand Mines (5s.)	3	1	3	4	12	6
Rand Selection Corporation	4	15	0	5	11	3
Randfontein Central		14	3	1	2	9
Robinson (£5)		16	0		15	6
Robinson Deep A (1s.)	1	0	0	1	10	0
Rose Deep		18	9	1	8	9
Simmer & Jack		4	6		7	3
Simmer Deep		2	9		3	6
Springs	3	11	3	3	2	6
Sub-Nigel	1	10	6	1	2	6
Union Corporation (12s. 6d.)		17	0	1	5	6
Van Ryn		17	0	1	3	9
Van Ryn Deep	3	12	6	5	17	6
Village Deep		18	0	1	0	3
Village Main Reef		14	6		10	6
Witwatersrand (Knight's)	1	2	6	1	5	0
Witwatersrand Deep		12	5		13	3
Wolhuter		5	0		6	3
OTHER TRANSVAAL GOLD MINES:						
Glynn's Lydenburg	1	5	0		17	6
Sheba (5s.)		1	6		2	9
Transvaal Gold Mining Estates		15	0		17	6
DIAMONDS IN SOUTH AFRICA:						
De Beers Deferred (£2 10s.)	18	2	6	31	10	0
Jagersfontein	4	12	6	7	0	0
Premier Deferred (2s. 6d.)	7	0	0	12	5	0
RHODESIA:						
Cam & Motor		8	3		10	6
Chartered British South Africa	1	3	0	1	2	3
Eldorado		6	0		6	3
Falcon		18	6		16	0
Gaika		16	0		16	6
Giant		8	0		9	3
Globe & Phœnix (5s.)	1	6	0		16	0
Lonely Reef	1	19	0	3	11	3
Rezende	4	10	0	3	12	6
Shamva	1	15	0	2	5	0
Willoughby's (10s.)		7	0		7	3
WEST AFRICA:						
Abbontiakoon (10s.)		5	6		6	0
Abosso		6	6		15	6
Ashanti (4s.)	1	2	0	1	4	9
Prestea Block A		5	6		5	0
Taquah		14	6	1	2	0
WEST AUSTRALIA:						
Associated Gold Mines		3	3		6	0
Associated Northern Blocks		4	5		4	9
Bullfinch		1	9		3	3
Golden Horse-Shoe (£5)	1	3	9	1	7	6
Great Boulder Proprietary (2s.)		12	0		10	6
Great Fingall (10s).		2	0		1	9
Ivanhoe (£5)	1	13	0	2	8	9
Kalgurli		11	6	1	2	6
Lake View & Oroya (10s.)		15	6	1	2	0
Sons of Gwalia		8	9		10	3
South Kalgurli (10s.)		7	3		6	3

GOLD, SILVER, cont.	Feb. 7 1919 £	s.	d.	Feb 6 1920 £	s.	d.
OTHERS IN AUSTRALASIA:						
Blackwater, New Zealand		8	9		8	9
Consolidated G.F. of New Zealand		3	9		3	9
Mount Boppy, New South Wales		3	9		6	0
Progress, New Zealand		1	9		1	9
Talisman, New Zealand		12	0		8	9
Waihi, New Zealand	2	2	6	2	7	6
Waihi Grand Junction, New Z'lnd		14	3		12	6
AMERICA:						
Buena Tierra, Mexico	1	1	3		16	3
Camp Bird, Colorado		17	9	1	3	3
El Oro, Mexico		17	0		16	3
Esperanza, Mexico		15	6		16	6
Frontino & Bolivia, Colombia		12	0		11	3
Le Roi No. 2 (£5), British Columbia		8	9		6	6
Mexico Mines of El Oro, Mexico	6	2	6	6	17	6
Nechi (Pref. 10s.), Colombia		12	0		10	6
Oroville Dredging, Colombia	1	0	6	1	9	0
Plymouth Consolidated, California	1	3	9	1	3	9
St. John del Rey, Brazil		17	6		18	6
Santa Gertrudis, Mexico		14	6	1	18	0
Tomboy, Colorado		14	6		13	9
RUSSIA:						
Lena Goldfields	1	15	0	1	5	0
Orsk Priority		13	9		12	6
INDIA:						
Balaghat		5	0		8	6
Champion Reef (2s. 6d.)		4	3		3	9
Mysore (10s.)	2	5	6	1	1	3
North Anantapur		3	0		4	3
Nundydroog (10s.)	1	1	3		15	0
Ooregum (10s.)		17	6		17	9
COPPER:						
Arizona Copper (5s.), Arizona	2	1	3	2	12	6
Cape Copper (£2), Cape Province	2	15	0	2	2	6
Esperanza, Spain		7	6		5	9
Hampden Cloncurry, Queensland	1	4	6		17	6
Kyshtim, Russia	1	15	0		—	
Mason & Barry, Portugal	2	13	9	2	10	0
Messina (5s.), Transvaal		5	0		6	6
Mount Elliott (£5), Queensland	3	10	0	4	0	0
Mount Lyell, Tasmania	1	4	6	1	6	6
Mount Morgan, Queensland	1	6	3	1	5	0
Mount Oxide, Queensland		6	6		8	6
Namaqua (£2), Cape Province	2	2	6	1	12	6
Rio Tinto (£5), Spain	62	10	0	47	10	0
Sissert, Russia	1	1	6		17	6
Spassky, Russia	1	15	0	1	5	0
Tanalyk, Russia	2	1	3		—	
Tanganyika, Congo and Rhodesia	4	1	3	3	0	0
LEAD-ZINC:						
BROKEN HILL:						
Amalgamated Zinc	1	8	0	1	6	0
British Broken Hill	2	7	6	2	3	9
Broken Hill Proprietary (8s.)	3	4	0	3	1	3
Broken Hill Block 10 (£10)	1	12	0	1	7	6
Broken Hill North	2	18	0	2	13	9
Broken Hill South	2	17	6	2	15	0
Sulphide Corporation (15s.)	1	6	0	1	1	3
Zinc Corporation (10s.)	1	7	3	1	1	6
ASIA:						
Burma Corporation	5	10	0	13	10	0
Irtysh Corporation	1	15	0		—	
Russian Mining		19	6		15	0
Russo-Asiatic	4	0	0		—	
TIN:						
Aramayo Francke, Bolivia	3	3	9	5	5	0
Bisichi, Nigeria		15	0		16	0
Briseis, Tasmania		5	0		5	9
Dolcoath, Cornwall		7	6		8	6
East Pool, Cornwall	1	5	0		18	3
Ex-Lands Nigeria (2s.), Nigeria		2	9		4	0
Geevor (10s.) Cornwall		19	6	1	2	0
Gopeng, Malay	2	1	3	2	5	0
Ipoh Dredging, Malay	1	0	0	1	2	9
Kamunting, Malaya	1	12	6	1	18	9
Kinta, Malaya	2	7	6	2	16	3
Malayan Tin Dredging, Malay	2	7	6	2	6	3
Mongu (10s.), Nigeria		17	0	1	7	6
Naraguta, Nigeria		18	0		17	6
N. N. Bauchi, Nigeria (10s.)		8	6		8	3
Pahang Consolidated (5s.), Malay.		14	6		15	3
Rayfield, Nigeria		14	6		14	6
Renong Dredging, Siam	2	2	6	2	16	3
Ropp (4s.), Nigeria	1	2	0		14	6
Siamese Tin, Siam	3	7	6	3	17	6
South Crofty (5s.), Cornwall	1	16	3		18	6
Tehidy Minerals (15s. pd.) Cornw'l	—			1	7	6
Tekka, Malay	4	2	6	4	16	3
Tekka-Taiping, Malay	3	17	6	1	6	3
Tronoh, Malay	1	17	6	2	12	6

* £4 shares split into 8 of 10s. each. † £1 shares split into 4 of 5s. each.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

MINERAL DEPOSITS IN FRENCH INDO-CHINA.

The *Far Eastern Review* (Shanghai) for November contains an account of the mines and mineral deposits of Annam, Laos, and Cambodia, French Indo-China. The information has been taken from the bulletin of the Comité d'Assistance aux Travailleurs Indo-Chinois. This article should be read in connection with that on the mineral resources of Tonkin, appearing in the Magazine for November. Unfortunately the article is not accompanied by a map, so that it is not possible to indicate the names of places and provinces in the sketch map which we have drawn for the purpose of this abstract. We had hoped that the new *Times* atlas would help, but were disappointed.

Annam.—There are only two mines actually opened in Annam. These are the coal mines of Nong-S'on and the gold mine of Bong-Mieu, both of which are in the province of Quang-Nam, about 100 kilometres south of Tourane. Deposits of zinc, antimony, and iron ores have been the subject of prospecting work, but this has not been followed up so far by active exploitation. With regard to general conditions, Annamite labour is better than that of the Tonkinese. The workers have been trained after the French school of miners, which has not always been the case in Tonkin. Transport conditions from the interior do not appear to be any different from those which exist in Tonkin.

Coal has been discovered in many parts of Annam, notably in the provinces of Quang-Nam, in the neighbourhood of the deposits of Nong-S'on, in Thanh-Hoa, and Vinh. In this last province, about 150 kilometres from Vinh, at Cu'a-Rao, there is a rich deposit of coal which it is not easy to work because of its distance away and the difficulty of transport. Prospecting work is actually now being carried out in connection with this deposit.

The Nong-S'on mine is situated 65 kilometres to the S S.W. of Tourane. It is reached by automobile road and river. The concession, granted for 29 years by the Annamite Government to a Chinese, passed from the latter's hands before that term expired into those of divers French proprietors and was transformed into their absolute property by a decree of January 12, 1910. For 15 years, from 1891 to 1906, these mines were the subject of serious research on the part of the French companies who were the proprietors during this period. At this time there were expectations of a rapid development of the port of Tourane, but these have not been realized. Beginning from 1906, after the liquidation of the Société des Docks et des Houillères de Tourane, the succeeding proprietors limited their efforts to extracting the coal from the best parts of the deposits found by their predecessors and were able to obtain an average of from 10,000 to 12,000 tons per year. This coal is analogous to the hard coal from the bay of Ha-long and of Dong-trieu in Tonkin. It is a poor anthracitic coal, containing about 7% of volatile matter. Its external markets are those of the Tonkinese coal, but up to the present the port of Tourane does not offer that quantity of freight necessary for an export of any considerable importance. As for local markets they are somewhat circumscribed by reason of the small development of industry in the region of Tourane. The mine provides work for a hundred Annamite labourers under a French master miner.

MAP OF FRENCH INDO-CHINA.

Bong-Mieu is the only gold mine worked by Europeans in Indo-China. In addition to this deposit, others, for the most part also situated in the province of Quang-Nam, have been discovered. In particular may be mentioned those of Vinh-Huy, Phu Muy, and Vinh-minh which show veins of rich quartz formerly the subject of important working by the natives. There are also, it is said, at Kim S'on, in the province of Binh-Dinh, old gold mines worked for many years by the Annamites for the Court at Hué.

The mines of Bong-Mieu are situated 100 kilometres to the south-west of Tourane, and are reached by road. The principal deposit outcrops on the northern flank of the Nui-kem, a hill belonging to the Annamite chain, a small range consisting of a series of heights not more than 500 metres. At the foot of this hill the Song-Van (the river of gold) flows in the valley of Co-bai towards Bong-Mieu. The management and the offices of the mine are installed at Co-Bai. One of the deposits is locally called the "Field of Gold." The region formerly had many ancient and important workings carried on for the profit of the Court at Hué. Work was not only done on the alluvial deposits of the valley, but also on the principal veins of Nui kem and that of the "Field of Gold." The first researches made by the French, 50 years after the stoppage of the native workings, took place in 1895. Since that time three companies having the same shareholders have with a tenacity and cleverness worthy of greater things, followed up this undertaking, difficult in many respects and particularly with regard to the treatment of the ores. The region is composed of gneiss covered by mica-schists running southward with a slight dip. The workings may for convenience be divided into three sections: that of Nui kem, consisting of the northern bank of the hill of that name, that of the veins of mispickel at Co-Bai on the right bank of the Song-Van facing Nui-kem, and the "Field of Gold" section near the village of Bong-Mieu on the river Song-Van and three kilometres upstream from Co-Bai. The "Field of Gold" shows numerous Chinese workings consisting of shafts of little depth rapidly reaching a pseudo-interstratified vein in the gneiss, and nearly horizontal. The pyritic ore which it contains appears to be similar to that of Nui-kem. At present the French workers are not occupied with it. In the mispickel lodes many levels, which to-day have fallen in, were apparently worked many years ago and show an arsenical mineralization which appears on the whole to be richer than the sulphide deposits in the Nui kem and "Field of Gold," but necessitating a more complicated treatment. Attempts at treatment by the bromo cyanogen process have not given satisfactory results. At Nui-kem there are three known veins, parallel to the strata. They are the "principal vein," "Vein No. 3," and the "superior vein." The latter has been worked by shallow shafts over a large area at the summit of the mountain. At present veins "No. 3" and "superior" contain only small workings. Exploitation has been principally carried on in the "principal vein." From this mine 80 tons of ore is taken out per day. This is sent to the mill at Co-Bai by an aerial ropeway. Sorting is done at the mine and afterward at the mill, where the large pieces of waste are removed. The ore goes through three Dodge crushers, working 10 hours per day, and 20 stamps. This plant has a capacity of 80 tons per day. The crushed ore is classified and sent to Ferraris sand and slime tables. Galena and pyritic concentrates are obtained. These and the tailing are cyanided. The power for the mine and works is supplied from a hydro-electric plant on the Song-Van about one kilometre upstream from Co-Bai and using a fall of 30 metres in 800 metres. A Neyret-Brenier turbine of 100 h.p. drives two alternators which generate a three-phase current at 550 volts. The personnel of the mine comprises six Europeans and about 400 Annamites, of whom 270 are miners, etc., and the rest labourers in the various workshops.

As regards zinc ores, the most important deposit is that of Duc-Bo, 50 kilometres S.S.W. of Faifo, the chief town of the province of Quang-Nam. This consists of a wide vein of sulphides of zinc, copper, and iron, in mica schists. The Quan-Son deposit is about 50 kilometres S.W. of Thanh-Hoa in the province of that name and consists of blende and galena in Triassic limestone near the contact with schists. Work on a fairly large scale has been done and some hundreds of tons of ore have been extracted. There should also be mentioned, in the province of Dong-Hoi, about 10 kilometres S.S.W. of the chief town of that province, the deposits of Duc-Thi consisting of impregnations of calamine and blende in the limestone, and of a vein of calamine only, also in the limestone.

At Moa-Ha, Vinh province, there is an ancient Chinese mine worked for argentiferous lead and blende, but now abandoned owing to water troubles. Copper has been discovered at Luong-So'u (Thanh-Hoa) and at Che-Cao (Vinh) in the form of sulphides and oxides. A deposit of sulphide and oxide of antimony in the form of fragments scattered in the clay of the surface covering the schists has afforded opportunity for a little working at Ta Soi, 150 kilometres N.N.W. of Vinh. Samples of antimony have also been found in the upper course of the Cam-Lo (Quang-Tri).

Numerous beds of iron ore have been noted on which there are small native workings. In particular in the province of Vinh there is the deposit of the "Pagoda Ne," situated 20 kilometres north of Vinh, which furnishes a hematite and limonite ore containing 60% of iron, and the deposit at Ve-Chinh, 10 kilometres S.S.W., where there is to be found a vein of iron ore with a high percentage of manganese in the quartzites, which are themselves penetrated by irregular veins of iron and manganese ores, forming locally at their junction masses of some importance. There are also numerous deposits in the province of Quang-Tri on the shores of the river of Cam-Lo, notably at the "Col des Canons" and at Pho-trach. At the latter some small workings yield a magnetite of good quality. There are also deposits of iron in the provinces of Quang-Ngai, Quang-Nam and Ha-Tinh. Deposits of chrome iron in the form of a detritus have been discovered in the province of Thanh-Hoa at Van-Am and Nui-Nua. Titaniferous sand is found in the bay of Cam-Ranh at Pagoda Point. There have also been found in the provinces of Tanh-Hoa and Vinh some deposits of phosphate of lime similar to those of Tonkin.

Laos.—There is not at the present time—nor has there been since the French occupation—any mine in regular operation in Laos. Numerous mineral deposits have been discovered, but the difficulties of transport and labour appear to have caused hesitation on the part of the French to study them deeply. Only the more profitable lodes of gold and tin, which the natives have worked since time immemorial and which are capable of yielding a small tonnage of high-priced material, easily transported, have engaged their attention. During this period many French companies obtained large provisional concessions but, with the exception of one or two, these companies did not fulfil the conditions which were imposed upon them and were deprived of their rights. In addition to the gold and tin the other deposits have not yet been made the object of research.

The only notable deposits of tin are those in the region of Hin-Bum at the places called Ban-Ta-Kua, Bo-Neng, and Na-Phan on the Nam-Pa-Ten, an affluent of the Nam Hin-Bum. Operations on a small scale have from time immemorial been conducted on these by the natives, who have produced from 10 to 15 tons of metal per annum. This was bought by the Chinese merchants at Pak-Hin-Bum, who exported it to Siam or sold it for weighting fishing nets. The natives work on the sand of the river and also in the clay. The natives smelt the concentrates on the spot. The metal produced contains from 96 to 97% tin. The deposit was the subject of investigation from 1899 to 1903, undertaken by the Société des Etains de Hin-Bum. It was shown that the cassiterite was irregularly distributed throughout the deposit. This was the principal reason why the undertaking was abandoned.

From the earliest times the inhabitants of Laos have exploited the auriferous alluvial deposits. The recent alluvial deposits are found in the beds of certain water-courses. These are principally in the upper course of the Me Kong river at Luang-Pra-Bang, which were made in 1904 the object of a concession, but no work has been done. Cemented alluvial deposits are the most frequent, and are exploited by the natives at Dong-Kieu, Hat-Kam, on the Me-Kong, and up the stream from Ven-Chan and also in the valleys of the Nam San (Veng-Chan), the Sebang-Hien (Savannakhet), the Houei Sang-Ngoi and Kou-tha (Cammon), the Nam-Ngun, etc. All the deposits mentioned have been conceded to French companies which to-day have lost their rights, owing to their having done no serious work on them. More recently investigations were made of the alluvial deposits of the Nam-San river, by the Compagnie Minière et Industrielle. This company brought in, at great expense and trouble, a large dredge, but went into liquidation before anything was done. Hillside alluvial deposits, worked by the natives, have been noted in the Pou-Long massif, between Pak-Beng and Xieng-Khong. The alluvial gold deposits of Laos have, up to the present, showed only relatively low gold contents, but the prospecting so far done has always been hasty and limited in extent, and work has never got down to bedrock.

Cambodia.—One mine only is in operation in Cambodia. This is the mine for precious stones at Phai-Linh, about 60 kilometres to the S.W. of Battambang, on the Siamese frontier. The right to work was granted by the Siamese Government before the cession of the Battambang territory to France. It is worked still by a colony of Burmese, but after having enjoyed 20 years of great prosperity it now appears to to declining. The sapphires and rubies are met at a depth of from 2 to 3 metres in a seam of alluvial clay resting on crystalline rocks, the nature of which varies so greatly that the origin of the stones has not been clearly proved to the satisfaction of geologists.

The iron mine of Phnom-Dek, 70 kilometres north of Kompong-Thom, was investigated in 1882 by Fuchs, who described it in his "Memoires sur les Gites de L'Indo-Chine" (*Annales des Mines*, 1882), as a huge rich mass traversing a hill formed of eruptive rocks. This favourable opinion has been confirmed by recent work carried out by a company, which contemplates the eventual treatment of the ore in electric furnaces supplied with power from the falls of the Me-Kong and wood charcoal from the Cambodia forests.

BROKEN HILL EXTENSIONS.

The report of Mr. W. H. Cundy on the geological structure of Broken Hill has just been published. It will be remembered that Mr. Cundy was employed by the Marshall brothers to report upon the properties north and south of the main line of lode in which they are interested, and to make a general survey of the district in order to check the Marshall-Jones synclinal theory, which, as already mentioned in our pages, challenges the geological theories upon which mining operations have hitherto been based. The fact that he supports the synclinal theory is of importance, not only to existing mines but to new ones which, while his researches were in progress, were under offer for flotation in London. The report deals separately with the extensions of the main lode northward and southward, and the following is a very full abstract.

South from the Central group of mines and after leaving the south shaft of the Zinc Corporation there is about a mile of flat alluvial country where the rocks are only exposed at intervals. Sufficient evidence, however, can be secured to enable the course of the main lode-channel to be laid down, and its position is further verified by the work done in several shafts and surface workings. The definite position of the main ore channel being thus established, its course can be followed to a depth with comparative ease now that the structural character of the ore-bodies is better understood. The old idea that Broken Hill lode did not extend beyond certain limits has long been exploded by the operations of the North Broken Hill Co. on the north and the Zinc Corporation on the south. In the lower levels on these two mines very extensive ore-bodies are being developed and it is likely that other ore-bodies will be discovered going southward if the mining operations are systematically directed. Once the main channel is located it is only a matter of following it to meet with recurring ore lenses both longitudinally and vertically.

When the records of the mines southward from the Barrier South to the White Leads are examined it is surprising to find how extensive and continuous the lodes have been, as the following instances will show. From the Barrier South it is reported that the bore below 930 ft. at 246 ft. passed through 18 ft. of dense sulphide ore, assaying 12% lead, 2·5 oz. silver, 26% zinc. This was at a period (1912) when zinc was a nuisance. It is further stated in the report that the lode at 930 ft. had been driven along north and south a total distance of 450 ft. with assay results from different places varying as follows: North level, 12·7 to 21% lead, 4 to 5 oz. silver, 27 to 30% zinc; south level, 8·4 to 25% lead, 3·3 to 5 oz. silver, 18 to 25% zinc. Two miles farther south, at the White Lead mine (now Marshall's Caledonian) it is recorded as late as 1918 that 140 tons of oxidized ore returned 7·5 oz. silver, 19·9% lead, 3·9% zinc, and that 1,177 tons of sulphide ore returned 7·5 oz. silver, 15·7% lead, 12·5% zinc. From the Rising Sun mine 1,000 tons of ore in one shipment returned 11% lead. These few instances as to values are given to show that average grade sulphide ore has been recovered.

The northern part of the Broken Hill field presents many features that are not seen at the south end, but this is accounted for by the fact that the country is more hilly and consequently the rocks and lodes are more exposed to view. The main centre line of lode is equally in evidence, but in addition there are numerous curved lode outcrops that are not so pronounced toward the south, which is due to their being covered by extensive alluvium and soil deposit.

The Round Hill outcrop on the east side, and the Potosi and Silver Hill on the west, appear to form main curves having some relation to each other, for they converge just south of the Imperial Dam on the south, and to the north near the Consolidated mine. Inside these there are numerous other smaller lode-channels which assume lenticular form as they draw nearer to the main centre line. Proceeding farther north, the lenticular formations recur again and again right on through the Globe mine and to Piesse's Knob.

Mr. Cundy draws attention to three important features regarding the structure of the Broken Hill district. (1) A main centre line which traverses the field from one end to the other for a distance of 17 miles. (2) The persistent dip of the rocks and lodes in opposite directions on each side of the centre line. (3) The existence of ore lenses formed in the rocks and their recurrence both on the surface and at great depths.

Mr. Cundy then treats severally of the different Marshall mines, two groups of which are now under offer of flotation in London, each for a million pounds. The first four are at the south end and the remainder at the north end.

Broken Hill Argus.—Total area 153 acres, and a length along the main lode-channel of 3,500 ft. Situated immediately south of the Barrier South Blocks and north of Block 10 Pumping Station leases. This area is in an extensive alluvial flat and very little can be seen of the surface rocks. Two shafts have been sunk, but no definite information is available in regard to the underground work. The last shaft is within a reasonable distance of the main lode-channel, but the other is altogether too far to the west.

Broken Hill South Extended. (Rising Sun).—Total area, 243 acres. It is situated south of the Block 10 Pumping Station and has a length of 2,700 ft. along the course of the main lode-channel. Some 2,000 ft. north of the main shaft considerable work has been done from a shaft said to be 500 ft. deep. At this point a large blow of lode material is seen extending over a width of 3 to 4 chains, which shows much copper staining, felspar, lead carbonates, oxide of iron, and manganese. The same lens structure is well defined, and other favourable characteristics are present and can be traced to the main shaft. The main shaft is 600 ft. deep, with cross-cuts at 100 ft., 260 ft., 300 ft., 400 ft., 500 ft., and 600 ft. To the east of the main shaft a bold quartzite lode is seen with iron and manganese stainings, carbonates, and nodules of quartz, with a covering of manganese-stained ore material.

Broken Hill Southern Dome Mines.—Total area, 95 acres. This property lies to the south and adjoining the Broken Hill South Extended Co. (Rising Sun), with Marshall's Caledonian adjoining on the south. There is a length of 1,350 ft. along the course of the main lode-channel. There is a shaft sunk near the north boundary of the area, but it will be necessary to sink a new one when active operations are commenced. There is not a great deal of information to be gained on the surface of this property, but the continuation of the lode-channel is definite and the same characteristics exist as on the adjoining properties. Lying between the Broken Hill South Extended and Marshall's Caledonian Mines, the situation is most favourable, as the two mines have each worked ore-bodies down to 600 ft.

Marshall's Caledonian Lead and Silver Mines. (White Leads).—Area, 105 acres, which gives a length of 2,580 ft. along the line of lode. The shaft is sunk to 600 ft., with levels at 132, 155, 303, 371, and 509 ft. The shaft is equipped with winding machinery and all necessary tools, etc., to immediately start operations. The surface lode has been followed continuously down to 371 ft., and some 700 ft. of cutting and 1,500 ft. of level driving has been done. During the past 2½ years complete results have been published. These show that fair-grade carbonate and sulphide ore has been produced (and still remains in the mine), but under the system of disposing of it the transport and treatment charges were so high that some other method of dealing with it must be considered. As an instance 163 tons of carbonate ore returned a gross value of £1,105, the treatment and other charges absorbed £701, leaving a balance of only £404. Returns to the end of 1917 showed sulphide ore produced 1,177 tons, averaging 7·5 oz. silver, 15·7% lead, and 12·5% zinc; carbonate ore, 140 tons averaging 7·5 oz. silver, 19·9% lead, 3·9% zinc. There is no doubt as to this and the Rising Sun mine being in the same lode-channel, as the baling operations in one mine affect the other.

Broken Hill Extended Silver Lead is at the northern end. Total area, 110 acres, with a length of 4,400 ft. Practically all the work has been confined to that on M.L. 220, and a number of shafts have been sunk, but none of them deeper than 60 ft. The main north shaft is only 40 ft. deep, and in it rich carbonate ore has been worked 3 to 4 ft. wide. In the shaft 25 ft. deep and 130 ft. south a small rich vein of oxidized ore has been followed down, 1 ft. 6 in. wide at the bottom. Some rich ore has been mined on this property, and it is surprising that more work has not been done to reach a greater depth.

Block 196 Co.—Total area, 80 acres, with a length of 2,650 ft. along the strike of the main ore-channel. A fair amount of work has been done, but unfortunately the main shaft is either filled in or covered over. Some evidence of rich carbonate ore is at hand, and a quantity of bagged ore still remains on the ground. The chief workings are on the west side of M.L. 42, where the main centre line is well defined, but to the south on Block 4 there is little information to be gained owing to the rocks being covered by alluvium. There would appear to be another defined lode-channel 150 ft. west of the centre line, on which a shaft has been sunk. The bold outcrop shows much copper staining and hematite on a strike of N. 55° E., and is worthy of further work being done upon it.

Broken Hill Options Ltd.—Total area, 80 acres, with a length of 2,900 ft. along the line of lode. The three blocks occupy an extensive flat of alluvial country, and there is no information to be gained, as the surface rocks are covered.

Broken Hill (Alma) Extension Ltd.—Area 122½ acres, south of and adjoining the Eastern Pinnacles Co. From the south boundary of M.L. 44 little can be seen of the lode outcrop owing to the alluvium covering, but from the north boundary through M.L.'s 23 and 34 the centre line lode-channel is well defined. The three leases give a length of 3,000 ft. and there are some interesting features to be seen, especially on M.L.'s 23 and 34. Near the N.W. angle there is a quartz outcrop which shows a fine sample of cubical galena, upon which no work has been done. On the main lode-channel several shafts have been sunk to shallow depths, and small but well defined ore-bodies have been worked from a few inches to 1 ft. wide. The lens formation is in evidence here, and ore has been worked for 3 or 4 ft. wide in places. Like all the north leases, there is an excellent opportunity for sound prospecting work on improved lines. All that has been done to the present is of little practical use, the old policy being evidently to follow small shoots of ore. There is evidence that some rich carbonate ore has been mined.

Eastern Pinnacles.—Total area 80 acres, situated north and adjoining the Broken Hill Alma Extension Ltd. From the south boundary of M.L.35 to Piesse's

Knob, a length of 3,000 ft., the lode outcrop is well defined on a strike of N. 20° E., and has been prospected at intervals for the whole distance. It was on these leases that Mr. Cundy first saw the importance of the lenses, as they are seen all along the outcrop and in the shallow workings, both in plan and cross-section. Good examples are seen on M.L. 40, where the lenses form one after the other up the south slope of the hill. They rest on the clean schist pitching rapidly to the north, but there is evidence that a channel forms under the bottom arch of the lens, and that others will recur at depth. There is a shaft near the workings on M.L. 40 that shows evidence of meeting with ore at depth.

Round Hill.—For many years it has been generally accepted that the Round Hill lode was the north extension of the Broken Hill main lode, but recent investigations show that this is not correct, as the north extension of the main lode lies far to the west of the Round Hill outcrop. This main centre line takes a course through mineral leases 10, 8, 6, 4, 2, and 3, in that order, and it is of the greatest importance that the country along this line should be systematically prospected. The Round Hill outcrop itself is a true lode-channel, but a subsidiary one to the Broken Hill Main Lode. When the new structural feature of the district is applied, there is every chance of the mine turning out successfully. The lens feature is very much in evidence in the outcrop, and also in the workings where they are accessible, and there is every probability of opening up other ore-bodies in the mine. Unfortunately, the plans give little or no detailed information, and what is required when the mine is reopened is to have the workings thoroughly examined and a definite working policy laid down under the new conditions now ruling.

MENTAL TREATMENT OF RETURNED SOLDIERS.

Those who met Mr. C. M. Harris, of Perth, W.A., during his recent visit to this country will be aware of his useful work done in curing shell-shocked and gassed soldiers by psychologic suggestion, or, to put it in simpler words, by kind Christian help. Brief reference has been made to this matter in the Magazine on one or two occasions, but the subject deserves more extended notice. We therefore print herewith his address delivered, in his capacity as chairman of the Mining Educational Committee of Repatriation, before the Guild of the Daughters of the Empire, in London during December.

"In speaking before this audience I do so, not as a lecturer, but as a prospector. Those of you who have read Ralph Connor's book "The Prospector" will realize that there are many spare hours in which men have time to think when they are prospecting. During the time I was a prospector I gave considerable thought as to how we could help those men who were back from the war and enable them to return to their pre-war avocation. I have the pleasure and honour of belonging to a communion which is known as the Ugly Men's Voluntary Workers' Association of Western Australia. It was with the intention of helping those who really needed it that in 1915, when the big casualty lists came pouring in from Gallipoli, half a dozen men of Perth, West Australia, clubbed together to form what they called "The Ugly Men's Voluntary Association," which is now abbreviated to "The Ugly Men." The basis of membership of that Association is that each man joining shall give not less than 40 half days' voluntary work on behalf of soldiers returning from the war. From the outset, the first work was to build houses for soldiers' widows. Blocks of land were presented, and materials were given by merchants. The idea caught on, branches were formed in other towns, and "Ugly Men's" houses stand as permanent and useful memorials in nearly every town in the State. Then came the S.O.S. signal for the training of men, who, returning from active service, were unable, from various causes, to return to their pre-war occupation. The Repatriation Board were paying out-of-work donations, but could not meet the demand for training, and the "Ugly Men" stepped in and established a training college near Perth. The instructors and other officials are men who have made their money and names as farmers and in other ways, and who are glad to help on with the work. That is to say, if a man wishes to become an agriculturist, he is taught something about soils and manures and how to fallow and how to sow, and then he will be instructed in harvesting and all its branches. Machinery merchants have lent a collection of farmers' implements from a spade to a harrow. Experts will show the men how to take these machines to pieces and how to put them together again, how to mend them, and how to work them. Then when they go on to a farm at wages which will be sufficient to support them, they will have further experience, which will presently enable them to start on their own account. By that time, the ex-soldiers will have a fair knowledge of what is required. When the course is completed, they will be guided by another committee in the choice of the land which the Government procured for them on very long terms. Thus, the man who wants to help himself is aided and assisted in every possible way. Such a scheme could only be carried out by the co-operation of many willing workers in all trades and professions. Already there are several hundreds of ex-service men who are in course of training, a training which has not cost them one penny.

"At the same time, a more difficult problem had to be faced: that of dealing with the men poisoned by gas. Some of the men were suffering from loss of voice, and others were being treated for tuberculosis and could not get better. Others had endeavoured to work or study but were unable to stick at it, and only too often they were called malingerers. Men who were dumb had been unsuccessfully treated in hospitals in London and Australia, and these were taken in hand by Mr. Lionel Logue, a teacher of voice culture. One case may be cited. Gassed at Ypres in August, 1917, this man was told in London that he would never speak again. Suggestion and hypnotic treatment at Tidworth hospital had been tried and failed. At the end of a week's quiet training under Mr. Lionel Logue, he was able to say, "Ah!" and at the end of six weeks he could speak fluently and easily. As I had been handling men suffering from gases caused by their employment in the mines in West Australia, for many years, I offered my services to deal with the miners who had been gassed, but were unable to get back to their normal health. At that time it was assumed that the effect of gas was only physical in its action on the lungs, and therefore that an out-of-door life with plenty of good food, no alcohol, moderate exercise, and no worry, would comprise the best cure, but it was necessary to give these men some employment, as they could not work in the mines nor on farms. As the result of a suggestion from a returned old-time prospector, he and several other men were given a course of training in the recognition and testing of minerals, as well as for gold, and from this they soon made a valuable discovery which made quite a sensation among "the diggers." Many more cases came along for training, which was extended as the time went on and men who, when they started on a course of mental training, were very doubtful as to whether they could stick it at all and make any progress became, at the end of a week, quite enthusiastic, and when they completed their prospecting tour, were well up to their usual condition of health. The very satisfactory results obtained by the first men who went through this course of training gradually got to the ears of the men who were lying in sanatoria almost hopeless. They had been there for months and months and could not see any chance of getting better. One of these was really only a boy. When he enlisted at 17½ years old in August, 1914, he went to Gallipoli, was wounded badly there, treated for his wounds and saw considerable service in France, gassed in Plug Street, treated in France for this trouble and later on in England. He was sent out as a last hope to Australia; on arrival there he was sent direct to a sanatorium to be treated for tuberculosis. This boy had been in hospital for 14 months and gradually got weaker and weaker, until he heard of this scheme, and he asked the doctor whether he would be allowed to go out, as he thought it would do him so much good. The doctor said "Oh, no! you had better stop here; you will be much better if you stay quiet in the hospital." The boy said "That is final; that means that I have got to die here; but if I have got to die, I might as well die in the bush. I have a chance there, and I haven't one here. I have seen too many men being carried out." He and his mate crawled out of the hospital somehow, and eventually they got to my headquarters. They certainly looked more like dead men than live men. They said they had come to see whether I could give them this training in scientific prospecting, so that they could go out on the Government Repatriation scheme. But right at that juncture I had to tell them they could not do so unless they had a doctor's certificate to say that they were well enough. The younger of the two men was almost broken-hearted at this. He had made up his mind that if he could go out on this work he would get well, and here was the barrier that he would not cross. He pleaded very hard to know if there was not some way in which he could be sent out. I did not know really what to do, because I knew the doctor would not pass him and therefore we could not get the money from the Government to send him out. But I sought courage and was able to tell him, "We will send you out and make yours a special case: I have some good friends who will stand in with me in this, and we will send you both out." So we sent him and his mate, with a nurse, because they were too ill to be sent out by themselves. In fact, we had to give them a month's quiet and gradual mental training before it was safe to send them. At the end of three months one of the two men had secured a position. The younger one, who was much the worse case, gradually improved, and at the end of twelve months he and I were able to do a 20 miles walk with our packs on in a little over five hours.

"Another case of which I may give the details in order to cite them was the following: I was sent for one day and my friends said, "There is a digger up here, a soldier; he is going to shoot himself. I wish you would see him." I, of course, saw him, and asked him what was the trouble. He answered: "I haven't got any friends, nobody knows me; what is the use of living?" I inquired what he was before, and it was explained that he was a prospector, so I knew immediately how I might handle him. I said to him, when I went along to see him, "Look here, I have a great big box of specimens down at my office, given to me for the training of returned soldiers, and I haven't got the time myself to tabulate all of these things, and you are the only man in Perth who can do it." He replied, "But I cannot do anything. I have only a day or two to live. It is no use coming in that way. I am gone. I am done." I said, "Well, if you want to die, won't you put it off for a week? wait until you have helped me out with this work and then we can see about it," and it was under these circumstances that he came to look at my collection. After working for an hour he said, "What time do you want me to start to-morrow?" I said "At 9 o'clock." He was there at the hour, and at the end of the week he was quite sane. At the end of a fortnight he felt that the world was not such a bad place to live in after all, and by the end of a month he secured a very good appointment where he still is.

"Other instances could be given in which men were quite unable to get a grip on life again, who, previous to the war, were good and intelligent workers. Now they are only too frequently pronounced to be wasters or mad. A number of these men have been brought back through the system adopted to their normal health and mentality and they are now in good posts. As the result of investigations made during the past three months in England, Scotland, and Ireland, in which I had an opportunity of talking to many ex-soldiers who had been gassed and who had been cured of their physical trouble, I found that this was followed by the usual mental apathy, but those who had been able to get some mental training in which they were interested succeeded in overcoming that trouble, although in many cases it required outside encouragement to help them to do so. As a result of consultations with psychologists, lecturers, and specialists in war-strain cases, together with the experience gained during the past three years, I, while admitting that I am a layman in psychology, make bold to state that thousands of ex-service men, many of whom are still in hospital and convalescent homes, and others who are waiting to get back to normal health, can be greatly helped, if not entirely cured, by means of the treatment based on the theory of those two eminent French physicians, Dejerine and Gauckler, who say that a conversational attitude, a familiar manner of asking things and talking things over, the heart-to-heart discussions where the physician must exercise his good sense, and the feeling on the part of the patient willing to be confidential, is the method which may be called 'psychotherapy,' by persuasion. It consists in explaining to the patient the true reason for his condition and for the different functional manifestations which he presents, and above all, in establishing the patient's confidence in himself and awakening the best elements of his personality so as to make them capable of becoming the starting point of the effort which would enable him to regain his self-control. The part the physician plays is simply to recall, awaken, and direct. We who are endeavouring to carry out this work at the present time want help, and the help of the doctors is most important. Unfortunately they have not got the time to go on with this work, which is really a work of re-education, and it is only through laymen volunteers that we can secure the greatest effect. What I want to urge is that, in numerous cases where men have been gassed, they can be cured if the right method be adopted in the right way, and that way is intelligent kindness and re-education."

BLAST-ROASTING PRACTICE AT PORT PIRIE.

The *Industrial Australian and Mining Standard* for September 25 publishes an article by Gilbert Rigg, on the use of granulated blast-furnace slag in the charge during the blast-roasting of zinc bearing lead concentrate at the Port Pirie works of the Broken Hill Associated Smelters. The introduction of granulated slag into the roaster charge when dealing with Broken Hill leady concentrates has been found to have certain advantages apart from the economy in the use of ironstone, which the slag largely replaces. This practice has been developed at the Port Pirie smelters during the past eight months.

The concentrates used at Port Pirie are divided into two classes, according to their mode of origin; concentrates from the jigs and tables, and slime concentrates from the flotation plants. The following analyses illustrate the composition of the two classes:

	Concentrate	Slime
	%	%
Pb	63·0	57·0
Zn	7·0	11·0
S	14·5	18·0
FeO, MnO	6·0	5·5
CaO	1·5	1·5
Al_2O_3	1·5	1·0
SiO_2	5·0	3·5

A certain amount of oxidized ore is used, and is usually referred to as silicious ore. The following is an analysis:

	%
Pb	20·0
Zn	4·5
FeO, MnO	15·0
CaO	2·0
Al_2O_3	8·0
SiO_2	40·0

In order to make clear the nature of the present innovation, some account of the roasting practice in general is essential. Roasting is done in two stages, a preliminary or "A" roast on a D. & L. machine, followed by a crushing of the A-sinter and a final or "B" roast of the A-sinter on Dwight & Lloyd machines or Huntington-Heberlein pots. In both cases the charge is the same and was, until the introduction of granulated blast-furnace slag, substantially as follows:

	%
Concentrates	49·0
Slime concentrates	18·5
Silicious ore	12·0
Limestone	6·0
Ironstone	14·5

This charge varied a little in accordance with small variations in the composition of the concentrates.

Originally, the fluxes were crushed through a ½ in. screen. Experience has shown that this was much too coarse. The notion that coarse pieces in a charge undergoing blast-roasting do open up the charge to the passage of the blast is to some extent true. But, on the other hand, such opening up is local, and encourages the blast to pass through the charge at favoured spots, while the denser parts of the charge go short. Other factors also militate against this practice. The concentrates, especially the slime concentrates, are finely divided, and, regarded as a uniformly distributed material, would no doubt effectively block the passage of the blast. Such materials, however, have the advantages of their defects. Finely-divided substances, when mixed damp, have a strong tendency to cohere into larger and porous aggregates, and in consequence present a relatively coarse structure. The presence of coarse pieces of ironstone and limestone interferes with this process by mechanically breaking down the aggregates during mixing.

Again, seeing that the blast-roasting charge only sinters and never enters the molten condition, pieces of limestone from ¼ in. to ½ in. diameter are only attacked at the surface. They are, however, largely burnt to lime, which slakes when the sinter is exposed to the air, and causes it to crumble and become unsuitable for the blast-furnace.

Moreover, the sinter coming from the D. & L. machines on which the final or "B" roast is performed is found to contain the coarser pieces of ironstone in an unaltered condition. This coarse unassimilated material helps to weaken the sinter. The recognition of these facts led the author to use fluxes in much finer form than before.

In the neighbourhood of the limestone quarries on Wardang Island, Spencer's Gulf, are sand-dunes composed of disintegrated limestone of the same composition as the solid limestone of which the island is composed. This sand will pass a 40 mesh screen. Substituted for the crushed limestone, it was found to work perfectly. The elimination of sulphur was good, and the final sinter was free from lime as such, and more resistant to exposure.

Ironstone screened through ⅛ in. gave good results in substantially smaller amount than had been used previously, and owing to the denser character of the charge, it gave a stronger sinter, and, while roasting, gave less trouble through blow-holes and dust losses than previously.

A similar line of action in regard to the crushing of the "A" sinter before passing to the "B" machine or H-H pots was attended with similar results.

The D. & L. sinter derived from this charge averages about as follows:

	%
Pb	44 to 45
Zn	5 „ 6
SiO_2	9 „ 10
FeO	16 „ 18
MnO	3 „ 4
CaO	4 „ 5
S	2 „ 3

On the blast-furnaces this sinter gave satisfactory results, the only addition made on the furnace being a little limestone.

The composition of the slag corresponding to this sinter is as follows:

	%
SiO_2	21·0
FeO	33·5
MnO	4·5
CaO	14·0
ZnO	13·5
Pb	2·0
	Oz.
Ag	0·75

The composition of this slag is unusual, and defies any attempt to figure out a silicate formula from it. It runs very fluid and separates well. Microscopical examination of thin slices shows that it is composed of two major constituents. The ground-mass is colourless, in thin section, and resembles fayalite, and is probably a lime-ferrous ortho-silicate. Scattered through this is a black to dark brown constituent, with indications of octahedral crystallization; also green octahedral crystals referred to gahnite are present. Frequently the silicate crystals are full of parallel rods, arranged like the teeth of a comb, and suggesting a constituent which separated from the silicate at the moment of freezing of the latter. The slag is decidedly magnetic, the powder being appreciably attracted by a permanent magnet.

Unfortunately, time has not yet been available for the final working out and diagnosis of these sections. Arrangements have now been made for a thorough investigation of the problem. In the meantime, the following working hypothesis has been adopted :

The silicate ground mass is an ortho-silicate of CaO, MgO, FeO, and ZnO. The black to brown mineral is a ferrite (RO Fe_2O_3), mainly a ferrite of Zn, possibly also a ferrite of lime and manganese, or, in other words, a franklinite. These two constituents exist in the molten slag in a state of mutual solution. In addition, it appears that ZnO is also present dissolved in the slag. The orientation of the rods referred to corresponds to the crystallographic structures of the silicate base, and, as suggested, they appear to have separated out at the freezing point of the latter.

The structure of this slag is of considerable interest, both scientific and technical, and it is expected that its final elucidation will not now be long delayed. Meanwhile, there is some evidence in favour of the foregoing hypothesis. In the first place ferric oxide is present in the slag. Its quantitative estimation is rendered very difficult owing to the presence of 3% of sulphur in the latter, which reduces the Fe to the ferrous state when the slag is treated with acid, but its presence has been qualitatively established. The formation of magnetite under blast furnace conditions when Fe is present and SiO_2 is deficient is well known. The colour and high opacity of the dark constituent and the magnetic character of the slag lend colour to the view that a molecule of the construction RO Fe_2O_3 is present.

Again, experiments on the use of a reverberatory matte settler yielded large masses of magnetic material which formed on the hearth and side walls and choked up the furnace unless the temperature was maintained high enough to prevent the separation. Incidentally, no matte separated at this temperature either.

Accepting this hypothesis provisionally, the next question that arose was, what would be the behaviour of the ferrite if added to the roaster charge as a substitute for ironstone ; in other words, if instead of using new ironstone blast-furnace slag was returned to the furnace. There were several congent reasons for doing this if possible. In the first place, there is good ground for believing that in the roasting charge ferric oxide serves as a carrier of oxygen to adjacent sulphides. This can only take place if the Fe is absorbed into the sinter. It has already been shown that ironstone in pieces too coarse for this absorption come through the process unchanged, and can be discarded from the charge without injury. The Fe in the slag is already in finely divided form, and the slag is very easily taken up by the sinter. Further, it was thought that the addition of slag would tend to strengthen the sinter which erred on the side of fragility.

The Zn content of the sinter would naturally be increased by addition of zinc-bearing slag to the charge, and in consequence the blast-furnace slag likewise, and the interesting question arose whether a Zn content could be tolerated in the slag which would make it commercially feasible to treat the latter for recovery of Zn. As regards this amount of Zn upsetting the running of the blast-furnaces, this was felt to depend mainly on how completely the sulphur was eliminated from the sinter. With sulphur well below 3%, troubles due to Zn largely disappear. These latter are mainly due to zincy matte and to accretion, in which ZnS plays an important part. Finally, the economy which would accrue from a reduction in the amount of ironstone required, and the cost of crushing it, were attractive.

Trials with crushed slag had been made some time previously with unsatisfactory results. Granulated slag being available, it was decided to utilize the slag in this form. It seemed to be in an ideal condition for this purpose. It consists of a mass of porous disintegrated grains, the great majority passing readily through a 4 mesh screen and yet free from powder, such as is produced in crushing. Such a material would give the maximum of useful surface and porosity.

After some preliminary small scale experiments, which were highly encouraging, the substitution of granulated slag for ironstone was put to work on the entire plant, turning out some 400 tons of lead per day. The following charge was used :

	(1) %	(2) %
Concentrates	40·0	49·0
Slime concentrates	25·5	18·5
Silicious ore	10·0	12·0
Limestone sand	8·3	6·0
Ironstone	4·5	14·5
Slag	10·0	—

For the sake of comparison, the composition of the original charge without slag is given in the second column. It will be noted that the percentage of slime concentrates has been increased in the new charge, this class of concentrate being more difficult to desulphurize than the coarse concentrate under ordinary conditions.

Average figures for the D. & L. sinter from this charge were :

	%
Pb	44 to 45
Zn	7 ,, 8
SiO_2	11 ,, 12
FeO	11 ,, 13
MnO	3 ,, 4
CaO	5 ,, 6
S	2 ,, 3

This sinter was of good grade and worked well on the blast-furnaces. The ZnO content of the blast-furnace slag was 17% and gave no trouble.

After running some weeks on this charge it was decided to try increasing the proportion of concentrates in order to improve the Pb content of the sinter. A supply of silicious ore not being available at this time, the deficiency in silica was made up by increasing the amount of slag, and adding a silica sand carrying 85% SiO_2. The charge had the following composition :

	%
Concentrates	47·0
Slime concentrates	27·5
Limestone sand	7·0
Ironstone	4·0
Slag	12·5
Sand (SiO_2)	2·0

The charge sintered well, the sinter having the following composition :

	D. & L. %	H. & H. %
Pb	47·5	48·5
Zn	7·5	7·5
SiO_2	8·0	8·5
FeO	13·0	14·0
MnO	3·0	3·0
CaO	6·0	5·5
S	2·8	2·7

Both D. & L. and H. & H. sinter were made from the same charge mixture, the small differences shown being due to slight variations in the constituents. The increased Pb tenor is noticeable. Up to 50% of Pb has been carried without trouble, although before the introduction of the granulated slag 44-45% Pb was the limit at which satisfactory sintering practice could be maintained. The equality in S content of both classes of sinter is also of interest, as prior to the introduction of slag the H. & H. sinter usually ran distinctly higher in S than the D. & L.

This sinter ran well in the blast-furnaces, the slag having the following composition:

	%
SiO_2	20·7
FeO	29·8
MnO	4·8
CaO	12·0
ZnO	18·7

The FeO content is 29·8% as against 33·5% when slag is not used. No Zn troubles were met with.

The next charge run had the following composition:

	%
Concentrates	47·0
Slime concentrates	27·5
Limestone sand	7·0
Ironstone	2·0
Slag	15·0
Sand (SiO_2)	1·5

This also sintered well. The composition of the blast-furnace slag was:

	%
SiO_2	24·2
FeO	25·6
MnO	5·3
CaO	11·0
ZnO	20·0

This slag ran well, and no Zn troubles were present.

In the foregoing slag analysis the Fe is expressed as FeO, as it also is in the sinters, but part of the Fe is present as Fe_2O_3 in both cases.

No additions of limestone or any other fluxes have been made to the blast-furnaces since the slag-sinter was used, the charge consisting of sinter, slag shells, and coke only. The Pb and Ag contents of the slag average 1% and 0·5 oz., respectively.

The use of granulated slag as a constituent of the roaster charge has now been proved. Its advantages may be summed up as follows:

(1) Better sinter physically, both D. & L. and H. & H.
(2) Economy in the use of ironstone.
(3) Economy in crushing ironstone.
(4) Higher Pb content of sinter, and consequent reduction in cost per unit of Pb roasted.
(5) Higher ZnO content of slag, which brings its recovery within the limits of commercial practice.

The new slag, while apparently of the same type as the old, differs markedly from it in its higher SiO_2, lower FeO, and higher ZnO content. Its further investigation, both from a theoretical and practical standpoint, promises interesting results.

The Fire at the Homestake Mine.—The *Pahasapa Quarterly*, the organ of the South Dakota State School of Mines, contains in its December issue an account of the fire at the Homestake gold mine which commenced in September last, written by R. G. Wayland, the chief engineer to the Homestake company.

The early mining on the Homestake ore-body was done on the square-set system, and an enormous quantity of timber was used. This system was discontinued in carrying up the stopes, and shrinkage stoping is now employed from the sill floor up to a point 25 ft. below the next level, leaving a crown of ore above each stope. After the broken ore is drawn and sent to the mill, a timber mat is laid on the sill floor and the empty stope is filled with waste from the level above. Subsequently the pillars and crowns are removed by square set stoping and filled with waste.

The fire started on the evening of September 25, 1919, above the top (sixth) floor of one of the small square-set stopes in No. 3 pillar north of the Star cross-cut of the 800 ft. level. This stope had broken into a large area of broken ore, waste, and timber above the 700 ft. level, and the night shift was engaged in drawing this ore. The broken ore and timber had arched over and hung up about 30 ft. above the grizzly, and in blasting it down the men set fire to some of the timber. They immediately tried to draw this burning timber out, but failed, and steps were at once taken to pipe water into the stope from the 800 ft. level. Smoke and gas from the burning timber soon rendered it impossible to work in the stope without rescue apparatus, and the gas was spreading to other parts of the mine. The work of building brattrices to isolate the fire area was therefore commenced at once. Wooden brattrices, plastered with cement, were built in all openings into this part of the mine on the 600, 700, and 800 ft. levels. The increasing volume of smoke and gas soon made it necessary to use oxygen apparatus in this work also. Later it was necessary to build brattrices on the 900, 1,000 and 1,100 ft. levels as well. At the same time, pipe lines were laid on the 600 and 700 ft. levels, and the area immediately over the fire was flooded with water. On the 600 ft. level a cross-cut was driven from the foot wall header into the caved ground above the fire, and an attempt was made to drive a pipe ahead to a point directly over the fire and turn water into this cavity. This work was done under the direction of the Bureau of Mines engineers. Two short headers were driven on the 700 ft. level in an effort to get near the fire, and in one of these some burning timber was encountered and extinguished, but without effect on the main body of the fire. This is the only instance in which fire was actually seen since the first night. Chemical apparatus from the Lead City fire department was used at this point, and a stream was kept playing for about twenty-four hours without any tangible result. In the meantime, car No. 5 of the Bureau of Mines had arrived at Lead, and its crew was giving every aid in the helmet work and in devising means for combating the fire.

On October 5, after a conference of department heads, it was decided to hang up the mills and flood the mines. On October 7 the first 12 in. pipe-line began to flow into the open-cut, and on October 9 the second one. These pipe-lines were each 600 ft. long, and were laid on the surface of Mill Street from a point in front of the General Offices into the open-cut. A 3 200 ft. flume was also constructed along the side of Whitewood Creek from a point a short distance below Kirk to the mouth of Savage Tunnel, which connects with the 300 ft. level of the Homestake mine. Water was turned into this flume on October 12. Water flowing in Deadwood Gulch at Central City also was caught up and pumped into the mine. The Golden Reward mine at Aztec, at the head of Whitewood Creek, was equipped with skips for unwatering the water flowing into the Savage Tunnel, three or four miles down the stream. The total amount of water running into the mines was about 1,300 cubic feet per minute, and the total volume to be filled was about 100,000,000 cubic feet.

Concrete bulkheads were built in all the openings from the Homestake mine proper into the Caledonia workings, so that these workings should not be flooded. The bulkheads were designed to stand pressure that would result if the mine were filled to the 300 ft level, and a large factor of safety was used. The lowest bulkhead was on the 900 ft. level and was 9 ft. in thickness. The bulkheads on the 800 ft. level were 6 ft., and the rest 5 ft. thick. Very little reinforcing steel was used, but a 12 in hitch was cut all around the sides, top, and bottom of the drift. On top this hitch was raised toward the Homestake side whence the pressure was to come. This was done to make a tapered bulkhead, and in order to make it possible to ram the concrete well into place. In all, eleven bulkheads were built. The concrete was mixed in a revolving mixer on the surface and transported in mine cars down the shafts to the various bulkheads. After the forms had been removed from the concrete a finishing coat was trowelled on.

All electrical machinery, drilling machines, locomotives, and everything that the water would damage were removed from the mine, and the levels were thoroughly cleared of rubbish, stray timber, and anything that could float about and cause damage. The shaft openings were laced to keep timber from floating into them and interfering with the skips or cages. As soon as the water was high enough in the mine the work of unwatering began. The main dependence was placed upon water skips operated by five of the hoisting engines, and upon air lifts. The pumps were, of course, also used as soon as it was possible. Stamps began dropping almost as soon as the work of unwatering was started ; and long before the mine could be entirely pumped out normal production would have been reached. The company was able to keep all of the mine and mill crews employed on the needed surface improvements and exploration work, so that the fire had little effect upon the community. Fighting the fire entailed a great deal of hard, disagreeable, and hazardous work, but the mine crew undertook it willingly and carried it out with great resourcefulness.

The Zinc Position.—The *Journal* of the Society of Chemical Industry for January 15 contains a review of the zinc position, written by H. M. Ridge.

In 1913 the world's zinc production amounted to to 982,000 tons, of which 32% was made in the United States, 28% in Germany, 20% in Belgium, and 6% in Great Britain. The consumption in Great Britain amounted to 23% of the metal produced in the whole world In the whole of the rest of the Empire only 3,700 tons was produced. An acute shortage of metal was naturally experienced in this country during the war, and prices rose phenomenally. Schemes were prepared for increasing the output, but the smelting capacity of the United Kingdom is still only 80,000 to 85,000 tons per year.

During 1919 the world's production amounted to about 520,000 tons, including 410,000 tons in the United States, but only about 20 000 tons in Great Britain, where the output has been limited by shortage of ore and by labour troubles. Belgium only recommenced smelting toward the middle of the year, and was hindered by shortage of ore and the difficulty of securing sufficient shipping tonnage even at high prices. During 1919 British imports of zinc amounted to 94,226 tons.

At the present time production is progressing satisfactorily in America, but Belgium is producing only 6,500 tons per month or 39% of the pre-war output, and Germany 3,500 tons or 14%, and Great Britain 2,000 tons or 40%. It is obvious that until conditions improve the country is dependent on American supplies. Owing to the necessity of preference being given to the shipment of foodstuffs, wool, and other essential commodities, zinc ore is being shut out, and there seems no prospect of the British or Belgian works being able to run their furnaces at full capacity during the coming months. Even then the output in the United Kingdom will be limited by the amount of plant available. If the country is to become independent of foreign supplies of zinc the extension of existing plants and the erection of new works are necessary.

During the war zinc smelting was classified as one of the important key industries, but no steps have yet been taken to make the country self supporting, although ample supplies of ore are available within the Empire.

For the ten years before the war the average price of g.o.b. spelter in London was £23. 16s. 5d. Since then the average prices have been :

1914	£23 6 8
1915	£66 13 8
1916	£68 18 11
1917	£52 3 6
1918	£52 4 0
1919	£42 5 3

In the treatment of zinc concentrates no radically new methods have yet proved suitable. Electrolytic precipitation has been tried in a number of works in this country, but all of these have been shut down, including the Hoepfner plant at Winnington, from which such a good product was obtained for several years. At the same time electrolysis has been adopted for the new plants in Tasmania, Canada, and at one works in the United States, but in each of these cheap power is available. Much progress has been made with the electric-furnace reduction in Norway, Sweden, and France, and the troubles experienced in the condensation of the zinc vapour have been largely overcome, but here also cheap power is essential.

Hand-rabbled furnaces for roasting are rapidly being replaced by mechanical furnaces, and these are already satisfactorily in operation in several works in this country. The saving in labour is important, and at the same time a more regular product is obtained and the consumption of coal decreased. The even supply of sulphur fumes materially facilitates the working of sulphuric acid plant, and avoids the losses of nitre which take place when hand furnaces have to be worked intermittently.

Pot making machinery was in the past obtained from Germany, but during the war complete plant for this purpose was designed and manufactured here, and has given entire satisfaction. Novel apparatus for more efficiently mixing the different clays has proved successful. Clay for pot-making used to be imported from Belgium, Germany, and Austria, but the war stimulated experiments with British clays, and these can be used equally as well as the imported materials, giving a good pot life when working at a high temperature. After drying and burning, the red hot pots have to be taken to the furnace and put into place. Even in this arduous operation hand labour is replaced by a simple semi-automatic apparatus, and a good deal of delay to the furnace is being saved by this means.

The results obtained with improvements in the design and construction of the zinc distilling furnaces are worth recording. To reduce 10 tons of ore 14½ to 15 tons of coal was formerly required for heating. In a plant built during the war the coal consumption has been reduced to under 8 tons, a figure which constitutes a world's record. The furnaces are built with counter-current recuperators, and there are no reversing valves requiring attention; the heat in the waste gases is so efficiently utilized to preheat the air that the temperature of the gas going to the chimney stack is reduced very much below what was formerly considered possible. Weighing, mixing, and transport of the charge to the furnaces is now done entirely mechanically, so that much labour is saved and supervision facilitated. Charging the pots in the furnace probably used to be the most laborious work of the zinc smelter, and this has been overcome with the aid of charging machines. These are driven electrically, and are much more efficient than hand charging, the pots being more uniformly charged and the charge denser. The duration of the manœuvre is shortened by about two hours, and the time for working off the charge is increased correspondingly, because 14 tons of charge can be fed into the pots in less than twenty minutes. The more extensive use of machinery reduces the number of men, and at the same time makes the management more independent of the skilled workmen.

Sulphates in Ore Deposits.—In *Economic Geology* for December, B. S. Butler discusses the presence of primary sulphate minerals in ore deposits. The author's summary is as follows: Sulphates in igneous rocks and in deposits formed at high temperature are confined to a few complex silicate minerals that contain the sulphate radicle. In deposits formed at intermediate temperature barite is common and anhydrite and celestite are not uncommon. Under favourable conditions and probably at comparatively low temperature alunite forms abundantly. In some deposits the sulphate radicle of the alunite was probably derived from deep-seated solutions. A study of volcanic emanations has shown that they exhibit changes in character, and that in the later stage of fumarolic activity they may contain sulphurous and sulphuric compounds. Sulphuric acid can readily be formed by the reducing action of sulphur dioxide on ferric solutions. If igneous emanations contain free oxygen and sulphur or sulphur dioxide it would be expected that, as they become cool, sulphur trioxide would be formed, and that at suitable temperature the sulphates would be formed. Sulphur trioxide is unstable at high temperatures, and the temperature range in which it forms rapidly and is stable is narrow. If emanations contain no free oxygen that combine with the metals or with hydrogen at high temperatures, they may at lower temperatures combine with sulphur to form the oxides of sulphur and sulphuric compounds. This interchange of oxygen from certain elements at high temperature to sulphur at lower temperature is believed to be an important factor not only in the formation of sulphates in solutions of deep-seated origin but also in the precipitation of primary (hypogene) ore minerals.

SHORT NOTICES

Mining Methods.—The *Engineering and Mining Journal* for December 6 contains a paper by S. H. Brockunier describing the method of mining at the Herman gold miner in Placer County, California. The stopes are worked by a system of rises within the ore-shoot, followed by panel mining.

Mine Valuation.—In the *Mining and Scientific Press* for December 27, Ross B. Hoffman describes a home-made instrument for calculating present values, net yearly earnings, etc., and solving various formulæ of this character.

Aerial Ropeways.—*Engineering* for January 16 describes a "semi-portable" system of aerial ropeways designed by the Aerial Ropeway Transporters, Ltd., London. This system does not require solid foundations for the piers, and is suitable for jobs that are likely to occupy limited time.

Concrete Headgear.—The *Engineer* for January 9 describes a reinforced concrete headgear at the Mary pit of the Fife Coal Co., Lochgelly.

Bucyrus Steam Shovel.—The *Engineer* for January 30 contains an illustrated description of the Bucyrus steam digger, mounted on caterpillar tracks, now in use at Harrow, near London.

Standard Chutes.—The *Engineering and Mining Journal* for November 8 publishes part of a report by C. A. Mitke on standard loading chutes for metal mines.

Miners' Nystagmus.—At the January meeting of the North Staffordshire Institute of Mining Engineers, Dr. T. L. Llewelyn read a paper on miners' nystagmus and the influence of defective eyesight on output.

Electric Lamps for Mines.—At the January meeting of the Manchester Geological & Mining Society, William Maurice read a paper on recent improvements in miners' electric lamps.

Ore Contracts.—In the *Engineering and Mining Journal* for November 22, C. A. Grabill commences a series of articles on modern ore contracts and the details of their requirements.

Giew Mill.—At the meeting of the Cornish Institute of Engineers held on January 24, S. Furze read a paper on the tin-dressing plant at the Giew mine, St. Ives.

Ball-Mills.—In the *Mining and Scientific Press* for January 3, H. Hanson writes on fine-grinding in ball-mills.

Alaska Gastineau.—The January issue of *Mining and Metallurgy* (the new name of the Bulletin of the American Institute of Mining and Metallurgical Engineers) contains a paper by E. W. Daveler describing the crushing and concentration plant of the Alaska Gastineau gold mine.

Copper Metallurgy.—The January issue of *Mining and Metallurgy* (the new name of the Bulletin of the American Institute of Mining and Metallurgical Engineers) contains a paper by Frederick Laist and H. J. Maguire on the treatment of converter slag in reverberatory furnaces as practiced at Anaconda.

Electric Zinc Refining.—*Chemical and Metallurgical Engineering* for December 10 contains a paper by F. A. J. Fitzgerald describing his radiant resistor furnace for the distillation of low-grade or scrap zinc.

Impurities in Lead.—At the December meeting of the London section of the Society of Chemical Industry, C. E. Barrs read a paper on impurities in lead as affecting the lead when in contact with hot sulphuric acid.

Steaming Amalgamating Plates.—The November *Journal* of the Chemical, Metallurgical, & Mining Society of South Africa contains the report of a sub-committee on amalgamation with special reference to steaming. This is in continuation of the discussion on a paper read at the May meeting, and reprinted in this Magazine for August last.

Weighing Gold Bars.—The November *Journal* of the Chemical, Metallurgical, & Mining Society of South Africa contains a paper by H. R. S. Wilkes on the causes of discrepancies between the mine and buyers' weights of gold bars.

Tungsten.—*Chemical and Metallurgical Engineering* for January 7 contains an article by Chester H. Jones describing the process of the Fansteel Products Co. for producing tungsten metal. The plant is at Chicago, and concentrates from Corea are treated. The wolfram is roasted with carbonate of soda, the tungstate of soda treated with hydrochloric acid, and the tungstic acid reduced with hydrogen. The method of treatment is described in detail.

Zinc Oxides.—The *Chemical Trade Journal* for January 3 contains an article by James Scott, describing the micro-structure of oxides of zinc.

Pyrites in Coal.—*Chemical and Metallurgical Engineering* for January 21 contains a paper by H. F. Yancey, assistant chemist to the United States Bureau of Mines, on the use of pyrites found in coal for the manufacture of sulphuric acid. The conclusions based on the result of his investigations and experiments are as follows: Most of the pyrites occurring with coal contains economic and useful percentages of sulphur; colour and physical appearance do not indicate the probable sulphur content; properly prepared pyrites concentrates do not contain injurious amounts of carbon; pyrites from coal contains only very small amounts of arsenic; pyrites from coal is mostly low in phosphorus. The scope covered by the investigation covered the coalfields of the eastern and central states.

S & M Tin-Wolfram-Bismuth Mine.—The *Proceedings No. 35* of the Australasian Institute of Mining & Metallurgy contains a paper by W. E. Hitchcock and J. R. Pound on the S & M mine, at Moina, north-west Tasmania, worked by the S & M Syndicate Ltd., of London. We intend to give an extended notice in the next issue.

Tungsten Deposits of Burma.—In *Economic Geology* for December, H. W. Turner reviews recent articles and papers on the tungsten deposits of Burma.

Tungsten Resources.—The *Engineering and Mining Journal* for November 1 contains an abstract of a paper by F. L. Hess on the tungsten resources of the world.

Bunker Hill.—In the *Mining and Scientific Press* for January 3, T. A. Rickard begins a history of the Bunker Hill & Sullivan lead-silver mines in Idaho.

Copper in Namaqualand.—The *South African Mining and Engineering Journal* for December 6 publishes a report by E. M. Weston, made for the Solomon Syndicate, on a number of copper prospects in Namaqualand.

Copper in a Meteorite.—*Economic Geology* for December contains a description by T. T. Quirke of a meteorite that fell in June, 1918, near Richardton, North Dakota. This meteorite contained metallic copper in veins of metallic nickel-iron and iron sulphide. The non-metallic part of the meteorite, 80% of the whole, consisted chiefly of olivine and monoclinic pyroxene. This is the first occasion that the presence of copper has been noted in a meteorite.

Potash in Spain.—In the *Engineering and Mining Journal* for November 8, Hoyt S. Gale writes on the potash deposits of north-east Spain.

Water Power.—At the January meeting of the Institution of Mechanical Engineers, E. M. Bergstrom read a paper on recent advances in the utilization of water power.

RECENT PATENTS PUBLISHED.

☞ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.2, with a note of the number and year of the patent.*

9,215 of 1917 (136,577). C. J. HEAD, London. Improved furnace for the treatment of tungsten ores with soda, having a filter bed of tungsten-bearing material which separates off the tungstate of soda and enriches it.

8,529 of 1918 (116,104). GALLOT & CO., and POUSSIN RONDEAUX & CO., Paris. Improved apparatus for electrostatic separation of dust from gases.

10,819 and 19,318 of 1918 (137,080). H. L. SULMAN and W. B. BALLANTYNE, London. Method of forming ferro-alloys containing tungsten, chromium, etc., by the thermo reducing process.

18,686 of 1918 (136,593). SIR R. A. HADFIELD, Sheffield. Method of making manganese-steel shovels and spades.

20,541 of 1918 (136,255). S. TUCKER, E. EDSER, and MINERALS SEPARATION, LTD., London. A frothing medium containing sulphur, made for instance by adding sodium sulphide to oleic acid. This medium can be used in selective flotation or in floating oxide ores, such as wolfram or cassiterite.

21,139 of 1918 (136,287). JOHN KING, Leeds. A system of visual electrical indicators for mines.

21,659 of 1918 (125,578). NORSKE AKTIESELSKAB FOR ELEKTROKEMISK INDUSTRIE, Christiania, Norway. Process for producing alumina free from iron by the treatment of labradorite.

21,759 of 1918 (136,309). UNITED FILTERS CORPORATION, New York. In vacuum filters with leaves mounted radially on a central shaft, methods of arranging leaves, removing the cake, and discharging it into the hopper.

21,916 of 1918 (137,110). G. A. OVERSTROM, Los Angeles, California. Improved method of causing the movement of ore dressing tables.

2,711 of 1919 (136,949). JOHN MORRIS, Maesteg, Glamorgan. Employment of a secondary wire rope supporting the two cages in hoisting gear, in addition to the main hoisting rope, as a precautionary measure in case of a hoisting accident, the secondary rope passing over a braked pulley in the headgear.

3,540 of 1919 (136,955). HENRY DAVIES, Crumlin, Monmouth. An improved telescopic metal pit prop.

3,915 of 1919 (136,957). P. A. MACKAY, London. Method for removing moisture from air before it goes to the blast-furnace, by passing it through a vessel in which sulphuric acid circulates under pressure.

4,562 of 1919 (136,718). CHEMICAL CONSTRUCTION CO., Los Angeles, California. Method of recovering potassium compounds from the dust of cement kilns.

10,188 of 1919 (136,750). AIR REDUCTION CO., New York. Method of making alkali metal cyanides by heating a mixture of carbonaceous material with an alkali metal compound in the presence of nitrogen and iron, the improvement consisting of the use of a smaller amount of iron than usual, from 2 to 5%.

12,498 of 1919 (136,459). W. W. RICHARDSON, London. Improvements in the inventor's system of concentrating alluvium.

13,336 of 1919 (136,464). INTERNATIONAL PRECIPITATION CO., Los Angeles. In the electrostatic system of precipitating fume, cooling the gases and humidifying them, so that water will precipitate on the electrode at the same time as the fume.

14,439 of 1919 (136,768). H. O. HEDSTROM, Djursholm, Sweden. Use of liquid sulphur dioxide in the extraction of radium from ores.

14,950 of 1919 (129,629). E. BERGVE, Notodden, Norway. Method of making alkali sulphide by the reaction of ferro silicon and pyrites on alkali oxide.

15,560 of 1919 (136,772). C. T. THORSELL and H. L. LUNDEN, Gothenburg, Sweden. In the reaction for producing cyanides by acting on carbonaceous matter and an alkali metal compound in the presence of nitrogen, a method of removing silica and alumina, two impurities which interfere with the reaction.

NEW BOOKS

Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 723, Salisbury House, London Wall, E.C.2.

Flow and Measurement of Air and Gases. By Alec. B. Eason, M.A. Cloth, octavo, 265 pages, illustrated. Price 25s. London: Charles Griffin & Co., Ltd.

The importance of the subject matter of this work to all engineers and especially to mining engineers is evidently very great; the mining engineer has to deal with it under two heads, seeing that he is deeply interested in the conveyance of compressed air underground, often for several miles, and that the proper regulation of the ventilating current that traverses his levels and working places is of vital moment to him. While this work has not been written at all with an eye to the needs of the mining engineer, it is nevertheless well deserving of his careful study, especially as there are few books devoted to the subject. Unfortunately the work is marred by several defects, which somewhat detract from its usefulness. Its main fault perhaps is that it is less a treatise than a compendium of information upon the subject, the author having collected together a mass of formulas respecting the flow of air in pipes, through orifices, etc., and having tabulated these with but little attempt at any critical analysis of their applicability. For example he gives a table showing the equivalent lengths of elbows and globe valves as given by different anthors, in which a number of most discrepant results are tabulated, but the only comment vouchsafed by the author is that "the variation between authors' values is very apparent." The reader surely has a right to expect some guidance as to whether he ought to select 0·5 or 4 as the proper co-efficient of resistance of a globe valve, but gets no assistance whatever on such points. The author does not even indicate which of these values he has found to approximate most nearly to the truth in his experience, nor indeed whether he has any personal experience in the matter at all.

A few chapters are devoted to the discussion of problems connected with pneumatic tube conveyance, a subject of considerable importance though not appealing much to mining engineers. On the other hand there are several chapters upon the measurement of air currents, which affect the mining engineer's work very closely. Here it is doubly unfortunate that the author is not more familiar with mining practice, as he might not only have given much additional information of value to the mining engineer, but would by a study of mining literature have gained himself a lot of valuable information that he has entirely missed. To quote only a few prominent examples, he has missed the classical work of Althaus upon the flow and measurement of air in his report for the Prussian Firedamp Commission (Anlagen zum Haupt-Berichte der Preussischen Schlagwetter-Commission 1887, vol. v, p. 135), the equally well-known work of Murgue upon the flow of air in mine galleries, an English translation of which is to be found in vol. vi. of the Transactions of the Institution of Mining Engineers, and the important paper of Rateau upon the theory of the Pitot tube and Woltmann mill, also translated in vol. xvii. of the same Transactions. Mr. Eason would have gained much from a study of such papers as these, and would probably have paid more attention than he has done to the anemometer, which he dismisses very summarily in a couple of pages, not even mentioning the use of recording anemometers. He devotes a useful chapter to the Pitot tube, though it may fairly be objected that he hardly pays sufficient attention to the tube used as a suction tube and to the co-efficient applicable to it. He gives a useful account of the principles of the hot-wire anemometer, though here too a somewhat fuller description of the instrument itself would have been desirable. Upon the whole the book will be found of use, mainly to the experienced engineer who wishes to have at hand a tolerably complete collection of formulas and constants, the discriminating use of which he will have learnt from his own experience.

HENRY LOUIS.

Memoirs of the Geological Survey, Vol. X. Iron Ores. The Hematites of the Forest of Dean and South Wales. By Professor T. F. Sibly. Paper covers, octavo, 94 pages, illustrated. Price 4s. London: E. Stanford.

This volume, like Volume VIII., has been born out of time. Had it appeared 40 years ago it might have been of some commercial use, if only to stimulate inquiry. Now it is largely of antiquarian interest only, particularly if it be correct, as the writer says on p. 26, that "The Forest of Dean is not far from exhaustion as a source of iron ore." That statement is, however, not justified by the facts revealed in the Memoir. It is altogether premature, not to say unreasonable, to condemn any district until its geological structure has been thoroughly mastered and correctly mapped. That, in a limestone district like much of the western side of the Forest of Dean or like the greater part of Furness, is a very difficult matter and cannot be accomplished in the manner adopted in these Hematite Surveys. Another statement is made on p. 23 for which I am unaware of any authority except the assumption, made later on in the Memoir, that the ore was formed by downward filtration. We are told that "Exploration in ground where the 'Crease' limestone is covered unconformably by Coal Measures would be unlikely to discover much ore." There have not been any results of actual work done to justify this statement, and when we remember that, in Furness, a large ore-body was worked beneath a considerable thickness of Yoredale Shales and that in the Whitehaven district some of the finest deposits of ore had a heavy covering of sandstone and shale, one cannot but feel that the above-mentioned opinion may do serious injury to the Forest of Dean and to the British iron trade. It is not improbable that some of the ore-bodies already worked were, at one time, overlain by Coal Measures. Since the ore was formed an enormous amount of denudation must have taken place.

From a prefatory note by the director we learn that Professor Sibly did this work without remuneration. That fact, I am confident, would not make him a whit less anxious to reach the truth, but is it creditable to the nation that scientific work, on which so much technical work depends, should be done in this way? "Surely, surely, a great rich country like ours will see that" its mineral resources, on which so much depends, are properly studied and described so that their exploitation may be conducted in a way most likely to be successful and at a minimum expenditure of time and money.

The scale of the geological maps is much too small, and little of the topography is shown, so that the geological boundaries are to a large extent matters of conjecture. Further, the maps do not show the position of a single ore-body. As a consequence of these defects the Memoir cannot be of any practical value. Yet it might have been made of very great value.

In the description of the Forest of Dean ore-field there is neither a plan nor section of any one of the numerous ore-bodies that have been found in that highly interesting district. There is no adequate description of their inner nature, no reference to the pockets of sand and clay they frequently contain. As a consequence readers, unfamiliar with the deposits, will most probably be led to suppose that they contain more ore than they really do.

Chapter V. relates to the so-called reserves, and Chapter VI. is a description of the mines and other works. Both these chapters could quite well have been dispensed with, and the space devoted to a fuller description of the ore-bodies. On p. 26 it is stated tha "The estimates (of reserves) are based upon the assumption that the yield of the ground known to be unexplored and confidently regarded as ore-bearing would be in fair degree proportionate to that of similar ground already worked." Could any statement be much more in the nature of a guess, or much farther away from the opinion now universally held by mining engineers of wide experience, that only blocked-out ore can be safely cubicated? I remember a very positive statement, in a report made for promotion purposes, that in a certain mine "750,000 tons of ore had been thoroughly proved." When that mine was exhausted only 44,000 tons of ore had been got. As might be expected the erroneous calculation was of ore in imagination only. It had not been blocked-out. With regard to the old mines it will readily be conceded, I think, that they possess little if any interest after the ore they were made to work has gone to the furnaces, whereas the forms and positions of the ore-bodies, whether working or exhausted, are always of interest and of the greatest value to the explorer.

The South Wales deposits are much more fully described than those of the Forest of Dean, but even that part of the volume leaves much to be desired. The sectional drawings are borrowed from another writer, and two of those drawings, Figs. 12 and 13, are of doubtful value. They are of the Mwyndy Mine. Fig. 12 is reproduced below as Fig. A. Fig. 13 is practically the same except that some of the conglomerate is removed to show that the ore in the early operations was quarried. When I visited the mine in 1885 with Mr. Stephen Vivian, who made these drawings, I had serious doubts as to their completeness. I could not then and cannot now understand how the conglomerate could rest on the ore, as shown, without the intervention of a fault coincident with the contact of the ore and overlying rocks. It is easy to see how such a fault could be omitted from the drawing. In the first place the initial operations in the working of the ore-body took place 64 years ago, when geological structure meant little in connection with ore-bodies, so that when the ore was quarried it is most unlikely such a fault would be noticed. Even later when the deeper-lying ore was mined it would require very great care to determine the existence of a fault having a shale as one of its walls.

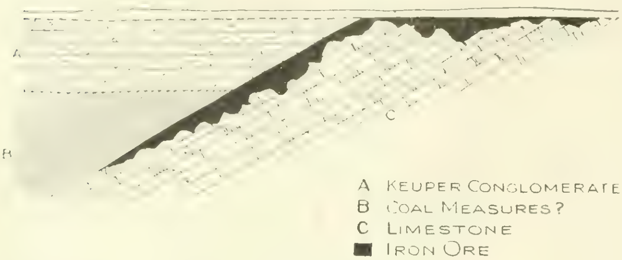


FIG. A.

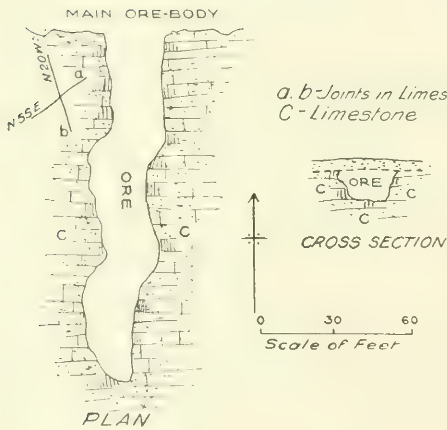


FIG. B.

Further, the mine was abandoned 35 years ago, and at that time the intimate relation between faults and ore-deposits had only been recognized about 9 or 10 years in West Cumberland and North Lancashire, where it was first noticed. That denudation should wear down the shale to the depth shown in the above section, without making any impression on the limestone which preceded the ore, would be a striking departure from its usual mode of operation.

On p. 56 we read: "Where the Keuper conglomerate overlies the Carboniferous Limestone the ore usually extends as a horizontal sheet beneath the conglomerate cover (Fig. 9, p. 68). This sheet-like extension is sometimes preserved beneath the glacial gravel (Fig. 12, p. 74)." On referring to p. 68 we find from the cross-section, which is part of Fig. 9, that the so called horizontal sheet is only a channel-like extension southward from the main ore-body, about 40 ft. wide and 150 ft. long. On p. 74, where the drawing above is given, there is not any cross-section, but, on referring to one of my 1885 note-books, it appears that I saw and recorded the following plan and section at Mwyndy. (Fig. B.)

This is what the Memoir calls a sheet-like extension. These finger-like extensions, as I prefer to call them, were of varying thickness, so that if denuded to a certain level would be broken up into separate basins One of such basins I saw in 1885 south of the Bute mine.

Although several faults occur in connection with these deposits not one of them is shown on the geological map, notwithstanding the fact that to them is due the localization of the deposits. The age of the faults shown in Figs. 8, 9, and 10 is between that of the lower Coal Measures and lower Keuper. There is not sufficient evidence to fix the age of the others, except of that which I suggest at Mwyndy; that is post-Triassic.

On the source of the ore the Memoir reads: "The immediate source appears to have been a mantle of Triassic (Keuper) deposits highly charged with ferric oxide, which overlay the denuded edges of the Carboniferous strata." I cannot find in the Memoir any evidence on which to found this statement. On p. 58

we read : "Iron ore occurs in the basal beds of the Keuper at their contact with the Carboniferous Limestone, but it is rarely developed in workable quantity. In the Llanharry mine this has been proved at many points, where the ore in the Carboniferous Limestone has been followed up to the overlying Keuper conglomerate." It may be thought by some that the existence of ore in the conglomerate is proof of the post-Triassic age of the ore-bodies, and that the source was the Red Rocks by which the district was overlain. But ore similarly mixed with the lower part of the Permian breccia occurs in the Whitehaven district where the breccia rests on ore-bodies. There, also, and likewise in Furness, we find ore mixed with gravel of the Glacial Period, where the latter rests on ore, so that such occurrences have not any definite bearing on either the age or source of the ore that lies below. In the Whitehaven district ore that is hard and compact below is frequently in a very fragmentary condition in the upper part, if overlain by either Permian breccia or Glacial deposits, and occasionally interrupted layers of ore occur in those deposits some height above the main ore-body. The Keuper conglomerate is distinctly suggestive of Glacial conditions.

I have shown in the "Formation of Coal" * that our coal seams and the whole Carboniferous system were deposited in basins. Those basins were in some cases formed by the Old Red Sandstone. The Permian and Triassic rocks followed the Carboniferous strata, in the same basins, notwithstanding the subterranean disturbances, the oscillations and denudations of which there is so much evidence. The intimate association of the Red Rocks with the Carboniferous system is readily seen on any geological map In all probability these Red Rocks owe their colour to the ejections or emanations of iron that took place during contemporaneous volcanic disturbances. The ore-bodies are most probably another phase of those hypogene activities as explained in the "Formation of Ore-bodies." † The age in the Whitehaven district and Furness is early Permian. In these S.W. districts, in the absence of definite local evidence, we may reasonably assume a corresponding age.

J. D. KENDALL.

Geology of the Country Around Lichfield. Paper covers, 310 pages, illustrated. Price 9s. net. London : E. Stanford, Ltd.

This memoir gives an account of the geology of the area contained in sheet No. 154 of the New Series of the one-inch scale geological map of England and Wales. Nine chapters are devoted to a description of the pre-Carboniferous formations, the Carboniferous rocks of the North Warwickshire and the South Staffordshire coalfields, the Triassic rocks, Pleistocene and Recent deposits, and the igneous rocks occurring within the area of the sheet. Special attention has been given to faults and extensions of the coalfields in Chapter VIII. Economic products of the district, including ironstone, but apart from coal, are dealt with in Chapter XI. In an appendix, records of a large number of shafts and borings for coal and water are given. The map of which this memoir furnishes a description has not yet been published.

Natural Wealth of Britain. By S. J. Duly, Cloth, octavo, 320 pages, illustrated. Price 6s. net. London : Hodder & Stoughton.

This book is one of a new series called the "New Teaching Series," and the author is a Cambridge man. The theme of the book is to show that geology is the basal science on which agriculture, mechanical industry, and material civilization itself is founded. This point of view is that which the Magazine has consistently adopted, so that the author's method of treatment of the subject is highly congenial to us. The book can be strongly recommended to students, and also to business men interested in mining and other industrial problems.

California Mineral Production for 1918. By Walter W. Bradley. Published by the California State Mining Bureau.

Sources of Industrial Potash in West Australia. By E. S. Simpson, I. H. Boas, and T. Blatchford Published by the West Australian Geological Survey.

Geology of the Country West of Sinoia. By A. J. C. Molyneux. Geological Survey Bulletin No. 6, Southern Rhodesia.

Smelter Treatment Rates. Report of the Committee of Investigation in the Matter of Tolls charged by the Consolidated Mining & Smelting Company of Canada, Ltd., Trail, B.C. Bulletin No. 30 of the Canadian Department of Mines.

Zinc and its Alloys. By T. E. Lones, M.A., B.Sc., LL.D. Cloth, small octavo, 130 pages, illustrated. Price 2s. 6d. net. London : Sir Isaac Pitman & Sons, Ltd.

Asbestos. By A. Leonard Summers. Cloth, small octavo, 110 pages, illustrated. Price 2s. 6d. net. London : Sir Isaac Pitman & Sons, Ltd.

Clays and Clay Products. By Alfred B. Searle. Cloth, small octavo, 165 pages, illustrated. Price 2s. 6d. net. London : Sir Isaac Pitman & Sons, Ltd.

COMPANY REPORTS

Mount Lyell Mining & Railway.—The report of this copper mine in Tasmania for the year ended September 30 last shows that 118,359 tons of smelting ore was mined at the Mount Lyell mine, averaging 0·4% copper, 1·2 oz. silver per ton, and 0·8 dwt. gold per ton, and that at the North Lyell the output was 76,058 tons, of which 61,141 tons averaging 7·55% copper, 1·94 oz. silver, and 0·2 dwt. gold was smelting ore, and 14,917 tons averaging 4·74% copper, 0·89 oz. silver, and 0·16 dwt. gold was sent to the flotation plant. At the Lyell Comstock, 15,588 tons, averaging 2·17% copper, 0·2 oz. silver, and 0·54 dwt. gold, was mined and sent to the flotation plant. It will be seen from the above figures that the output of ore was much below normal, owing to scarcity of labour. The flotation plant treated 30,468 tons of ore averaging 3·43% copper, and produced 8,622 tons of concentrate averaging 10·95% of copper, the percentage of recovery being 90·4. At the smelting works, 116,375 tons of Mount Lyell ore, 60,194 tons of North Lyell ore, 7,890 tons of concentrate, and 718 tons of purchased ore were treated for a yield of 5,773 tons of blister copper, containing 5,314 tons of fine copper, 266,864 oz. silver, and 5,538 oz. gold. The ore reserve is estimated as follows : Mount Lyell, 1,910,388 tons averaging 0·5% copper, 1·5 oz. silver, and 0·8 dwt. gold ; North Lyell, 960,242 tons averaging 6% copper, 1·33 oz. silver, and 0·1 dwt. gold. It has been possible to do rather more development work than during several years past, and in the North Lyell mine exploration has disclosed further amounts of high-grade ore. Experiments have recently been conducted with leaching processes.

Champion Reef Gold Mining of India.—After having paid dividends continuously since 1894, this company, operating in the Kolar district of Mysore, finds itself unable to make any distribution for the year ended September 30 last. The report for this period

* Trans. of The Canadian Mining Institute, vol. xxii, 1919.
† Ditto vol. xxi, 1918.

shows that 140,553 tons of ore was milled, for a return of 69,688 oz. of gold by amalgamation, being a yield of 9·9 dwt. per ton, and of 9,321 oz. by cyaniding, being a yield of 1·3 dwt. per ton. In addition, 66,369 tons of old tailing yielded 4,999 oz. by cyaniding. The total output of gold was 84,008 oz., selling for £356,103, as compared with £399,505 the year before. The working profit was £46,976, but after allowance for income tax, depreciation, etc., the net profit was only £6,243, which was carried forward. The ore reserve was estimated on September 30 at 293,515 tons of unspecified content, as compared with 335,949 tons the year before. The development during the year has been disappointing, but the amount of work possible in this direction has been greatly curtailed by war conditions. An expansion of exploration is contemplated. The sinking of the three auxiliary shafts in Garland's, Glen, and Carmichael's sections is being continued. As regards metallurgical treatment, it has been found that slime treatment is cheaper and gives a better extraction than sand treatment, so the scheme is to be altered to all-sliming.

Kampong Kamunting Tin Dredging.—This company was formed in the Federated Malay States in 1913 by Sydney capitalists to acquire alluvial tin ground at Kamunting, Perak. The first dredge started work in March, 1915, and the second in February, 1916. The report for the half-year ended June 30 last shows that the two dredges treated 907,000 cu. yd., for a yield of 350 tons of tin concentrate, selling for £43,830. The net profit was £19,402. The dividends distributed absorbed £24,500, being at the rate of 3s. 6d. per £1 share. Work was not done under the most advantageous conditions. No. 1 dredge had a new ladder put in, and in order to bring it to a suitable position for the substitution to be effected, some ground already treated had to be passed through. No. 2 dredge was for some time in ground containing limestone pinnacles and heavy timber. Both dredges are now in much better ground. Additional property has been purchased, and the life of the company has been thereby extended from 10 to 12 years. The company has a substantial interest in the Asam Kumbang company, which has just started dredging.

De Beers Consolidated Mines.—This company was formed in 1888 to consolidate diamond-mining operations at Kimberley, Cape Province. Production was suspended from the outbreak of the war until 1916. The report for the year ended June 30 last shows that the amount of blue ground hoisted from the Wesselton mine was 1,035,311 loads, from the Bultfontein mine 1,262,942 loads, and from the Dutoitspan mine 1,389,833 loads. The amount of blue ground washed was: Wesselton 1,657,146 loads, yielding 0·24 carat per load; Bultfontein 1,629,198 loads, yielding 0·31 carat per load; Dutoitspan 1,066,465 loads, yielding 0·17 carat per load; total 4,352,809 loads. During the previous year 6,595,078 loads was raised, and 5,843,099 loads was washed, the fall being due to the long stoppage owing to the influenza epidemic. The reserve at Wesselton down to the 980 ft. level is estimated at 10,000 000 loads, and from that level to 1,550 ft. at 22,000 000 loads. At Bultfontein the reserve down to the 1,000 ft. level is estimated at 6,000,000 loads, and from that level to 1,600 ft. at 22,000,000 loads. At Dutoitspan the reserve down to 750 ft. is estimated at 11,500 000 loads, and from there to 1,300 ft. at 25,000,000 loads. The accounts show sales of diamonds £5,849,552, and working costs £2,335,881. Taxes absorbed £382,379, and £698,798 was placed to reserve. The dividends were £740,000 on the preference shares and £2,000,000 on the ordinary shares, the latter being at the rate of 80%. As already recorded in the Magazine, the profits since the closing of the year ended June 30 last have continued to expand.

Natal Navigation Collieries & Estate.—This company was formed in 1897 under Transvaal laws to acquire coal lands at Hatting Spruit, Natal. Shares are held in the Northern Natal Navigation Collieries Co., formed in 1917 to acquire coal areas in the Paulpietersburg district of Natal. Dividends have been paid regularly since 1900. The report for the year ended June 30 last shows that 248,501 tons of coal was raised, as compared with 285,476 tons the year before, the fall being due to the influenza epidemic and to the shortage of railway trucks. The profit was £86,670, and a small dividend was also received on the North company's holding. The dividends distributed absorbed £41,900, being at the rate of 10%. A large amount of cash, £213,223, is kept in hand in order to provide working capital when a new property is acquired, a contingency anticipated owing to the proved area at present worked being restricted. A fourth pit is being sunk to develop a remaining portion of the area. Prospecting by drilling on some adjoining properties has given disappointing results, which tend to show that the Natal coalfield is not so extensive as was at one time supposed.

Chinese Mining & Engineering.—This company was formed in 1900 to acquire coal mines at Kaiping, in the state of Chih-li, north China, and it was reconstructed in 1912 in order to effect a working arrangement with the Lanchow company, a Chinese-owned company operating in the same neighbourhood. The businesses of the two companies are now controlled by the Kailan Mining Administration. The report for the year ended June 30 last shows that the sales of coal by the Kailan Administration amounted to 3,128,677 tons, as compared with 2,996,668 tons the year before. During the current year a further increase has occurred, and the figure for the year is estimated at 4,000,000 tons. Arrangements are now in hand for extending the operations so as to bring the yearly capacity to 4,500,000 tons. The proved reserves in the mines under Kailan control are estimated at 23,450,000 tons. The Kailan net profits were $5,995,734, of which $3,162,910 accrued to this company. The net profit of the company was £653 873, out of which £200,000 has been distributed as dividend, being at the rate of 20%, income tax paid. The amount reserved for excess profits duty is £300,000. A substantial part of the company's profit comes from the rise in the eastern dollar.

Witbank Colliery.—This company was formed in 1896 to acquire coal lands in the Middelburg district of the Transvaal, about 90 miles east of Johannesburg. The control used to be with Neumann's, but passed to the Central Mining & Investment Corporation in 1917. The sale of coal commenced in 1898, and increased gradually until 1909, since which year the yearly output has been fairly regular. The report for the year ended August 31 last shows that the shipments from the Witbank mine were 471,400 tons, and from the Uitspan mine 396,454 tons, making a total of 867,854 tons, as compared with 907,738 tons the year before. The decrease is due partly to labour shortage and partly to irregularity in the supply of railway trucks. The accounts show a profit of £86,261, out of which £12,153 was spent on capital account, and £7,284 was paid as taxes. The shareholders received £63,000, the dividend being at the rate of 30%. The developments continue to be satisfactory. Since the beginning of operations in 1898 the total production of coal excluding duff has been 10,794,136 tons.

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CONTENTS.

EDITORIAL

WHEN writing last year of the celebration of the centenary of James Watt's death we stated that "no foolish statue was to be erected." This expression of opinion recurred to our mind when we read the circular of the Institution of Mining and Metallurgy asking for subscriptions toward the erection of an elaborate sculpture in memory of members fallen in the war. A second circular has since been issued indicating that the bulk of the money subscribed will be devoted to a more benevolent purpose. This change of policy is highly commendable, and was no doubt prompted by advice tendered.

IN this issue we publish a short but interesting article on the Levant mine, written by Major Francis F. Oats, the engineer in charge. For the last two or three years Major Oats, as chairman of the cost-book company, had to bear the brunt of the battle at this mine against nature, labour conditions, and unsuitable financial methods, and this in spite of his military duties. With the conversion of the old cost-book company into one of limited liability, and with the provision of adequate working capital obtained thereby, the mine has clearly received a new lease of life. We have on a previous occasion referred to Mr. Oliver Wethered coming once more to the rescue of an old Cornish mine which by force of circumstances stood in danger of becoming derelict, the first case having been that of Dolcoath, in 1895. With Mr. Wethered as chairman of the company and Major Oats as manager, the prospects at Levant are undoubtedly bright.

MUCH has been done during the last three or four years by our scientists and engineers in the way of research and compilation of information. Unfortunately the results of their labours have rarely been published and the records have been largely pigeon-holed. Even when they are published, their surroundings are usually such that their existence escapes notice. For instance, Professors Cullis and Carpenter, of the Royal School of Mines, made a report on the World's Production of Silver for the Committee on Indian Exchange and Currency. This has now been published among the appendices to the Committee's main report. We frankly confess that we did not know of this report on silver until Professor Cullis drew our attention to it. It occupies sixty closely printed pages of foolscap and contains a mass of information of interest to both mining and business men. Really it should be issued in book form, for the demand might be considerable.

MR. H. C. Hoover took up the presidency of the American Institute of Mining and Metallurgical Engineers at the New York meeting which opened on February 17. With his usual vigour he departed from the common presidential practice of reviewing past events in the annual address, and commenced instead a campaign for improving the position of the American bituminous coal-mining industry. The subject was discussed in comprehensive detail, and his treatment of it showed his characteristic administrative ability. The session was one of extraordinary interest, and the attendance of members and visitors was easily a record.

SEVERAL useful handbooks relating to mining and the production of metals have been published during the past month. Skinner's "Mining Manual & Mining Yearbook" has been for over thirty years the recognized work of reference relating to mining companies known in London. Quin's "Metal Handbook" gives statistics of production and a record of prices of the commercial metals. Jackman's "Tin Mining Handbook" gives particulars of tin companies. Meredith's "West African Market Handbook" deals with companies operating gold mines in West Africa and tin mines in Nigeria.

MINING engineers, like all other professional men, are suffering severely from the high cost of living, and they may be said to belong to the class nowadays called the "new poor." The Institution of Mining and Metallurgy has drawn attention to this condition of things, and is urging that mining companies should treat their professional employees in an appreciative spirit, and increase their remuneration on a scale corresponding to the advance in the workmen's wages. Unfortunately at the present time the tendency among companies and other employers of professional mining men is to bid the applicant down. Multitudes of mining engineers went to the war, abandoning their prospects and career for a time, feeling confident that grateful fellow citizens would see that they did not ultimately suffer any social or pecuniary disadvantage. It is sad to record that many men have been cruelly disappointed when, on demobilization, they have sought to return to their old profession. Applicants have been greater than the number of places offered, and the old law of supply and demand has come once more into force, so that salaries offered have not only been incommensurate with the increased cost of living, but are in fact lower than before the war. It is to be hoped that employers will take a broader view and look rather for efficient service than for pettifogging savings in the salary list. The problem is seen therefore to comprise two separate sections. In one case those already in positions are seeking rises to keep pace with their expenses. In the other those out of place are struggling to regain even the old nominal value of their services. Both classes of engineers deserve consideration on the part of directors and private employers, but undoubtedly the latter class have the first call.

GEOLOGICAL investigation by aeroplane does not seem at first sight to be practicable, but since the reading of a paper before the Royal Geographical Society describing the discovery of the traces of an ancient unknown city in Mesopotamia by this means, incredulity on the subject is no longer pardonable. In the course of the flight from Cairo toward Cape Town, Dr. Chalmers Mitchell made observations that are distinctly useful to the geologist, and his detailed report is awaited with unusual interest. In the meantime Professor J. W. Gregory has announced that Dr. Chalmers Mitchell's messages contain useful hints as regards the theory of the Great Rift Valley, of which more anon. There can hardly be any doubt as to the value of views from overhead of surface geology, for the outcrops of lodes or the indications of their presence may be more recognizable from this aspect than from the limited range of view of the pedestrian.

This reminds us of an old story, probably untrue but *ben trovato*, of the shareholder who spoke many years ago at a Dolcoath meeting. In referring to the prosperity of the mine, he said that Dolcoath had been successful for many years, was successful then, and that after he went aloft he hoped to look earthward and witness a long continuance of active operations. An unkind critic rejoined that the shareholder might do more good to the company if he decided to adjourn downward instead of upward at the conclusion of his sojourn in life, because then he might be able, by wireless or spiritualistic message, to tell them something of the persistence of the ore in depth and of the paragenesis of the various minerals in Cornish ore. Perhaps, in view of the evidence of Dr. Chalmers Mitchell and Professor Gregory, that shareholder was as knowing as his critic.

ON another page the secretary of the Broken Hill Associated Smelters calls attention to an example of the inaccuracies of statements often made by mine-owners in course of their public controversy with smelters. It can be said without offence that mine-owners have sufficient legitimate grievances against smelters without having to invent them, and one careless statement does more harm to both sides in the dispute than can easily be estimated. As an example of a genuine grievance in connection with Australian metal mining we may quote the present position of the small copper mines which are still receiving only the par value for their gold content. The contracts call for payment based on 85s. per ounce, and the refiner is reaping the whole benefit of the premium. To put the matter specifically, copper ores have to be smelted within the Commonwealth, and blister containing recoverable gold and silver contents must be refined also within the Commonwealth, and chiefly at Port Kembla by the Electrolytic Refining Co. This company is owned by a number of the leading copper producers, who, of course, receive their benefits from the premium on gold out of the profits of the refinery. There are, however, producers of blister who are not shareholders in the Electrolytic company, and they get no advantage. It is not necessary to mention names, for they are well enough known to the Australian metal controllers.

AT the meeting of the Institution of Mining and Metallurgy held last month the subject of discussion was the bromocyanogen process. It seems late in the day to be studying this phase of cyaniding, but the meeting was pleasant enough, and several old friends gave reminiscences of twenty-five years ago. To many, bromocyanogen is nothing but a name, and, generally, only those who have had experience in West Australia are acquainted with the process, its applications in other countries, such as Canada and South Africa, having been limited. Briefly stated, the effect of adding this compound to the cyanide solution is to increase greatly the rate of action, presumably owing to the rapid oxygen effect, thus making it possible to employ the cyanide process on ores containing compounds of the sulphide and telluride types which introduce complications when the operation of the process is leisurely. Improved and cheapened methods of roasting and fine grinding have made it possible to treat the most troublesome ores by ordinary cyanide practice, so that bromocyanogen is seldom if ever adopted at new plants nowadays. The theory of the action is still obscure, but it provides subject for discussion, and further investigation would undoubtedly add to our knowledge of cyanide chemistry. The authors of the paper presented were Messrs. T. B. Stevens and C. E. Blackett, and it naturally suffered to some extent by their absence, both of them being in West Australia as metallurgists. Many points open to criticism and question might have been cleared up if they had been here to reply and amplify. The discussion was interesting, for informative speeches were made by Mr. H. L. Sulman (the co-inventor of the process with Dr. Teed), Mr. Alfred James, Mr. J. E. Clennell, and Mr. Bertram Hunt. Mr. James mentioned that the process was the sole chemical improvement introduced into cyanidation since it was brought before the public by Messrs. MacArthur and Forrest, and he thought that if Mr. Sulman had not received the gold medal of the Institution for his work in connection with flotation, he would have deserved it for his invention and application of bromocyanogen. All of which goes to show the high esteem in which Mr. Sulman is held by his colleagues in this country.

A year ago we protested against the incompleteness of the returns issued by the Board of Trade relating to the imports and exports of metals and minerals. In our pages devoted to statistics, the figures for imports into this country are scanty, and readers are continually inquiring why the table cannot be expanded ; but we are powerless in the matter. A short time after we wrote the article, it was announced by the Board of Trade that the manner of issuing the returns was to be modified and improved. Under the circumstances criticism was suspended, and the new system was awaited with interest. But, as is so often the case with Government action, the realization proves to be not equal to the hope, for the new tables commencing with the returns for the January trade are no better than the old ones. It is true that figures for boron minerals are given separately from those for commercial borax, but that is as far as the improvement goes. On the other hand, copper ore is now massed with matte and precipitate, instead of being given separately as before. The chief point of objection to the returns, however, remains, that is to say, most metals and minerals are lumped together as "other articles," and their identity thus disappears. There is no mention of aluminium, nickel, antimony, arsenic, bismuth, tungsten, chromium, molybdenum, cobalt, either as metal or ore, nor are there any items relating to lead or zinc ores. Non-metallic minerals other than stone, slate, and coal are not specified, so there is no indication of dealings in asbestos, mica, corundum, graphite, magnesite, fluor-spar, or soapstone. Whether those in authority consider these matters to be of little importance, or whether those interested have a pull with the Government enabling them to preserve secrecy, we do not know. The segregation of imports and exports by countries continues to be imperfect. Usually the "other countries" account for more than those specified, while in certain cases, notably petroleum and its products, no country of origin is included in the returns. All this is very disappointing. We cannot do more than continue to draw attention to the incompleteness of the trade figures.

Civil and Mining Engineering.

From time to time during the last year or so we have drawn attention to the proposal for the establishment of a register of qualified mining engineers emanating from the Institution of Mining and Metallurgy and the other three societies interested in the scope of these subjects, namely, the Institution of Mining Engineers, the Iron and Steel Institute, and the Institute of Metals. The benefits to be derived from such a policy are sufficiently obvious, and need not be elaborated on this occasion. We have also referred to a similar policy promulgated by the Institution of Civil Engineers, and have recorded that this society is asking Parliament to sanction a change in its constitution which would give it control of all civil engineering work ; that is to say, a committee composed preponderatingly of its members would be given power to prepare a list of those qualified to conduct civil engineering operations. At first sight this action of the institution seemed commendable, and worthy of imitation by other societies jealous of the reputation of their respective professions. But on looking through the terms of the Bill, mining engineers see proposals which cause considerable disquietude, for the wording is interpreted to mean that mining engineering is included within civil engineering, and that mining engineers will have to apply to the aforesaid committee for permission to practise their profession. There is no denying, in our opinion, that mining is a branch of civil engineering, for the chief operations involving the outlay of money are the moving of earth and rock. Even if this generalization is not agreed to, it is clear that a great many operations which the mining engineer is called upon to undertake come within the scope of civil engineering. The objects of the agitation for a register are the same in both cases, and a fusion of forces and interests in the campaign for placing the profession on a proper basis would obviously be desirable; in fact the mining engineer might, theoretically, be glad of this unequalled opportunity for attaining this end. The theoretical, however, often differs widely from the actual, and in the present case anxiety arises owing to the fact that the mining engineers would have to go before a committee composed almost entirely of civil engineers before they can qualify to continue their own profession. It is quite properly argued that the railway, harbour, and water-supply engineers are not necessarily competent to judge of the qualifications of the mining engineers, and it is claimed that the mining engineers should have a very much larger representation on the committee than is offered. At the present time the chances do not seem bright for the mining engineers gaining this increased representation, and the only alternative has been to lodge a notice of opposition to the Bill. It is clearly a pity that so admirable a policy should be wrecked or should create unreal differences of opinion between influential societies. The fact that the two mining institutions have secured Royal Charters should be sufficient to warrant expectation that the Institution of Civil Engineers will yield a point. So we must hope for the best.

While writing about these registers, it is opportune to call attention to an anomaly that often arises out of the varied qualifications for membership of the Institution of Mining and Metallurgy. The scope of the institution includes the mining of non-ferrous ores and minerals and the extraction of metals or the preparation of other saleable material therefrom. Thus the membership includes mining engineers and mining geologists on the one hand and metallurgists and chemists on the other. To the outsider the "M.Inst.M.M." conveys no information as to the particular qualifications, and it is often assumed that a member is equal to any job throughout the range of subjects. Thus we find a metallurgical chemist being asked to report on an oil property, and an expert on mine development receiving an offer of a position in the smelting department. Our recollection is that, in earlier days, the list of members of the Institution indicated the department, mining or metallurgy, to which each member devoted his attention. The revival of such a practice would be distinctly helpful if the proposals for the establishment of a register of mining engineers or of civil engineers do not materialize.

Chandler, Perkin Medallist.

In all probability the name of Professor Charles Frederick Chandler, the latest recipient of the Perkin Medal, is unknown to the majority of the readers of this Magazine; but when it is mentioned that he was one of the founders of the Columbia School of Mines, immediate interest will be aroused. In addition, Chandler is also deserving of permanent recognition for his services in spreading the cause of chemical education in America and in demonstrating the necessity of intelligently applying science to industry. His views, methods, and career were in many ways similar to those of Sir Henry Roscoe in this country. He was not so much an original thinker or investigator as a great educationalist and administrator, founder of colleges and technical societies, and mentor to the chemical engineer and manufacturer.

The Perkin medal was instituted by the late Sir William Perkin, himself a great applier of science to industry, and it is given every year by a committee of the chemical societies of America to men who have won distinction in industrial chemistry. In previous years we have reproduced the professional biographies of other recipients, such as Acheson, of carborundum fame, and Frasch, the remover of sulphur from petroleum. It is appropriate to continue the record and give some particulars of the life and work of Professor Chandler.

Charles Frederick Chandler was born in 1837 in New Bedford, Massachusetts. While at the local school he evinced great interest in the chemical studies. His elders did not chaff him on his keenness, and airily refer to a "passing phase," so we find him at the age of sixteen at the Lawrence Scientific School where his bent could find full play. While here he was encouraged by Dr. Charles Joy, of the Union College, Schenectady, to go to a German University, and he accordingly spent a year at Göttingen in Dr. Wöhler's laboratory for advanced students, and another year in Rose's private laboratory at Berlin. On his return to America in 1856 he joined Dr. Joy at the

Union College, and, on the removal of Dr. Joy to Columbia College a few months afterwards, succeeded him in the charge of the chemical department at Union. This position he held until 1864. In this year Professor Thomas Egleston and General Vinton decided to make efforts to start a school of mines in connection with Columbia College, New York, and invited Chandler to join them. Many people thought this a rash venture, likely to fail. They were wrong, of course, for they omitted from their calculations any consideration of the personal magnetism of the founders. Columbia was at that time an old college, with only a limited local patronage, and it seemed to some people folly to found a course of mining study in association with it. The eventual result, however, is well known. The school of mines succeeded so brilliantly as to put life into the college, and rapidly attracted students not only from all parts of the United States but from Australia and South Africa, and more recently from Japan and China. The new school opened its doors in November, 1864. The rooms were in the basement of the old college building on Madison Avenue, and accommodation for twelve students was provided in the laboratories. As 24 students presented themselves on the opening day, further rooms were acquired, and the accession of new men continued, until at the end of the first year the number had risen to 47. During the summer vacation of 1865, a factory building nearby was acquired and accommodation was arranged for 72 students. Again the applicants exceeded expectations, for 89 men registered for the second year. Afterwards a new building with accommodation for 150 students was erected from Chandler's designs, and this was soon full to overflowing. The success of the venture having been proved beyond question, Columbia College began to expand in other directions, and became eventually a congeries of technical schools. At first, Chandler was professor of geology and mineralogy as well as of chemistry and assaying, but J. S. Newberry was later appointed professor of geology and Chandler was then able to devote his attention entirely to chemistry. From 1864 to 1897 he was dean of the school, resigning in the latter year when the college moved to its new quarters at Morningside Park. From then onward until 1911 he was Mitchill professor of chemistry, and had charge of the magnificent Havermeyer Hall, which is undoubtedly the finest chemical laboratory in the United States.

So far we have referred only to his collegiate work. As an editor, he conducted an American supplement to the *Chemical News*, of London, and in 1870 he founded the *American Chemist*, and he also undertook much laborious work in connection with the chemical section of Johnson's Encyclopedia. But more important than this editorial work was his creation of the American Chemical Society. At first, only a local society of chemists was formed in New York in 1876. It soon became clear, however, that a national rather than local society was required, and in 1878 the American Chemical Society came into existence. This venture was as successful as the school of mines, and the society is now one of great power and influence. A remarkable evidence of the vitality and resources of the society is the fact that it publishes three separate monthly periodicals, all of first-class importance, dealing with different sections of pure and applied chemistry.

In the domain of industrial chemistry, Chandler has contributed largely to the success of many processes and has made many valuable suggestions. He was the originator of the system of assay weights put on the market by the firm of Becker, and it was by his advice that the Castner caustic soda process was developed on a large scale. He had also much to do with the agitation for pure drugs and chemicals, and was effective in helping to start several firms, notably Eimer & Amend, which had this object in view. His work in connection with the improvement of lighting oils is well known. He did immense service to his country and to the world at large by indicating the way to make kerosene safe for the purposes of illuminating lamps, and also to produce a kerosene product not liable to smoke. He was also a great authority on the quality of water, and his advice was continually sought in connection with the New York supply. Medicinal springs received his attention, and he made many reports on their contents and alleged virtues. Lead poisoning, in connection with water supply, plumbing work, and cosmetics, provided him with many lines of investigation. Sugar refining and air in underground railways occupied much of his attention. As an expert witness in the patent courts he has been continually in demand. Taking all his activities into consideration it will be seen that his life has been an exceptionally strenuous and busy one. At the age of 83 he is as active as ever, helping in the organization of the American chemical industry for the purpose of combating the renewed German competition. May he live long to enjoy the never-ceasing admiration of his fellow-countrymen.

REVIEW OF MINING

Introduction. — International exchange has continued to be the controlling feature of the situation in metals. New York exchange continued low during February, and the prices of gold and silver soared to new records. Early this month the Government announced that steps would be taken to liquidate the first Anglo-French loan in the United States, with a consequence that exchange recovered considerably. The metal markets showed substantial advances in prices for a time, but quotations have fallen away again. The decision of the Bolivian Government to impose a profits tax on mining companies accounted for some part of the rise in tin.

Transvaal.—A month ago the controllers of the gold mines were congratulating themselves on having settled, for a time at least, the disputes with white labour. Almost immediately afterwards, however, the natives at many mines became restive and for a week or two the affair had an ugly look. At the time of writing the disturbance seems to have subsided and the boys have returned to their work.

The effect of the gold premium on the profits of Transvaal gold mines is shown by comparing the returns for December and January. In the former month they were calculated at the par value of gold and in the latter they were figured tentatively with gold at 107s. 6d. During December, 20 out of 43 mines showed a loss, whereas in January only City & Suburban, Durban Deep, Goch, and Princess Estate found their balance on the wrong side.

It is proposed to amalgamate the Rand Selection Corporation with the Anglo-American Corporation of South Africa. The latter company is offering eleven shares in exchange for five Rand Selection shares. This will call for the creation of 1,320,000 new Anglo shares. The company has a large interest in the new diamond company, of which particulars are given in another paragraph.

Cape Province.—The prospectus of the Mount Ayliff Syndicate, Ltd., has been advertised. The object is to provide further funds for the exploration and testing of the copper-nickel ore deposits owned by the Insizwa Nickel, Copper, & Cobalt Developing & Mining Co., Ltd., situated in the Insizwa Range, East Griqualand. Mr. W. H. Goodchild is at present engaged in the development of the property.

South African Coal.—Arrangements have been made for shipping African coal from Durban to Marseilles for use on the French railways. It is said that trial shipments may be made to England for the purpose of filling the requirements of steamers, and thus relieving the results of congestion in the home colliery output.

Diamonds.—The "Consolidated Diamond Mines of South-West Africa, Ltd.," has been registered at the Cape with a capital of £4,500,000 in £1 shares to acquire for £3,675,000, payable as to £1,775,000 in shares, the assets of the principal producing mines in the South-West Protectorate from the former German owners. Debentures for £1,850,000, bearing interest at 8%, redeemable in 1929, and convertible into shares at par for 10 years, are to be created. Five of the nine members of the board have been nominated by the Anglo-American Corporation of South Africa and its associates, the Hon. H. C. Hull being chairman. According to a statement made by this gentleman, the areas acquired by the company have a producing capacity of more than 90% of the entire output of the Protectorate. The plant and equipment are stated to be of up-to-date type, and included in the purchase are the railway line and equipment between Lüderitzbucht and Bogenfels which serve the properties in that area.

Congo.—The output of copper at the Union Minière smelters during 1919 was 23,000 tons, about 1,000 tons more than the estimate given by Mr. Robert Williams at the meeting held a few months ago. The present rate of output is over 2,200 tons per month and there is every prospect of a continued increase.

Rhodesia.—The Falcon Mines output in the year ended June 30, 1919, was on a reduced scale, and the working expense ratio was higher. 150,961 tons of ore yielded 3,023 short tons of blister copper, estimated to contain 2,967 tons fine copper, 33,597 oz. gold, and 68,794 oz. silver, the total value being reported as £411,744 or 54s. 6d. per ton of ore treated. This compares with 57s. 1d. per ton in 1917-18. Working costs (exclusive of London expenditure) averaged 47s. 7d. (against 46s. 9d.), and the mine profit was 6s. 11d. (against 10s. 3d.). The year's profit is returned as £56,320 (against £88,449), but debenture and loan interest took £18,600, and £30,000 has been appropriated for debenture redemption. The credit balance of £159,907 (including the amount brought in from 1917-18) is carried forward with a view to accumulating a sufficient cash balance to serve as available working capital. Ore reserves show a falling off in both quantity and grade, while mine-workers' wages have had to be increased since the close of the past year. Mr. Cyril E. Parsons, the consulting engineer, writes that the reduction in estimated value of the ore reserves may not be reflected in the outputs, "but must be regarded more in the light of a precaution in case the grade falls, due to an admixture of waste." Development at the 11th level has been disappointing, the area of ore exposed being much smaller than at higher levels, but Mr. Parsons does not regard the position as hopeless, as he says it is possible an improvement in the size of the deposit may take place in depth.

There has been a split among the directors of the Globe & Phœnix company owing to the chairman, Earl Russell, alleging that two directors, Messrs. Hope and Macquisten, conducted negotiations with Mr. Latilla, of the Rhodesian Exploration Company, without the rest of the board being cognizant of what was going on. Earl Russell called a meeting of shareholders with the object of removing these gentlemen from the board. In the event, however, the chairman found himself outvoted on the resolution. Presumably some resignations may be expected at the annual meeting which is nearly due.

West Africa.—The output of gold during December was worth £98,806 (par value), as compared with £98,322 in November and £112,621 in December, 1918. The total output for the year 1919 was £1,240,691, as compared with £1,333,553 in 1918, and £1,529,977 in 1917.

Nigeria.—The company owning South Crofty mine recently decided to embark on tin ventures outside Cornwall. It has now participated in the flotation of Kuru South, Ltd., which has been formed to acquire from the Niger Company a number of leases near those of the Kuru and N. N. Bauchi companies. Messrs. Laws, Rumbold & Co. have reported favourably on the chances of discovering tin-bearing deep leads that formed part of buried river beds, as well as on the prospective value of the surface gravels.

A company called Nigerian Consolidated Mines, Ltd., has been formed to acquire alluvial tin properties from Mr. W. E. Thomas, lately manager of the Keffi company. There are three separate groups of properties in the Rayfield, Jemaa, and Womba districts respectively. All three groups are producers and are capable of considerable expansion.

Australasia. — English participation in Hampton Plains properties is extending. The Bullfinch has acquired an option on Treloar's Mutooroo lease No. 24, and Mr. C. S. Honman will supervise operations. The control of the White Hope Company, which owns Slavin's Find, has been bought by Messrs. Lionel Robinson, Clark & Co., and the shares will be offered in London shortly. This firm is the chief guarantor of capital for the various ventures in this new district, and their action has made it possible to test the deposits thoroughly. It is to be hoped this firm's mines in the Celebration neighbourhood will have better luck than those at Bullfinch.

Hampton Uruguay, Ltd., is to be reconstructed, as the Hampton Gold Mining Areas, Limited, for the purpose of dealing with its property on Block 48 Hampton Plains. The company, originally called Hampton Plains Estates, was formed in 1894 at the time when this district was first believed to have great potentialities as a gold producer. In those days Hampton Plains proved disappointing. Subsequently the company tried a property at Norseman, and afterward attention was turned to Uruguay. For some years thereafter nothing was done, and the company went into liquidation. The liquidator, Mr. St. John Winne, however, always believed that the Hampton Plains property might be worth something, and the company was never actually wound up. The opportunity now arises for resuming exploration work, and, by the aid of Messrs. Lionel Robinson, Clark & Co., about £80,000 will be available for this purpose.

Conditions have been unsatisfactory at Yuanmi for several years from the points of view of ore developments, labour, and cost of supplies. Just recently, however, more hopeful results have been obtained by diamond-drilling and driving. A continuation of an excellent body of ore near P shaft has been discovered by diamond-drilling at the other side of disturbed ground. This ore-body was worked to a depth of 130 ft., but below this to the 200 ft. level little ore was found. At a depth of 489 ft. the bore indicates a gold content of 102s. per ton over 5 ft. On the 7th level from the main shaft ore of better quality has been found recently, and the existence of a payable parallel lode has been proved. The directors have decided to raise additional funds in order to go ahead once more. For this purpose 500,000 preference shares of 2s. each are to be offered for subscription to shareholders. At the same time the ordinary shares, of which there are 350,000, are to be reduced in nominal par value from £1 to 17s. 6d.

Last month we referred to the Yampi hematite iron ore deposits on an island off the northwest coast of West Australia, and mentioned that the West Australian State Mining Engineer had been examining them. It is now announced by cable that an option on the property has been secured by the Queensland Government, presumably in connection with its national scheme for iron smelting. This scheme is centred on the Mount Biggenden magnetite deposits. No doubt it is considered desirable to have hematite ores to treat concurrently.

Derek's Tin Mines, Ltd., is the name of the company formed by the F.M.S. Timah group to acquire the Lass o' Gowrie and You & Me lode tin properties in the Herberton district of Queensland. Mr. George Macfarlane reports the ore reserves at 40,000 tons averaging 3% of SnO_2, and recommends the expenditure of £30,000 to continue development and provide equipment.

India.—Following on the sale of its copper mines in Spain, as reported in the Magazine for September last, the Cordoba Copper Company has turned its attention to India, and has acquired an option from the Cape Copper Company to prospect part of the copper belt on which that company's Rakha Hills mine is situated. Bore-holes, adits, and shallow shafts have proved the existence of copper ore for several miles. At Mosaboni, a level 80 ft. deep is in ore for 564 ft., averaging 3·4% over 4¾ ft. The arrangement between the two companies is that the Cordoba shall conduct development costing at least £1,250 per month over three years, and that when a new company to work the property is formed the companies shall share the purchase price and contribute equally to the working capital, which shall not be less than £100,000.

Considerable difference of opinion existed among both directors and shareholders as to the future policy to be adopted with regard to Hutti (Nizam's) gold mine in Hyderabad. This mine is now down 3,300 ft., and for the last 1,000 ft. development has been disappointing. The engineers, Messrs. T. & W. Morgans, were not in favour of further sinking, but drew attention to two points, on the 1,800 ft. and 2,040 ft. levels respectively, where lateral prospecting appeared promising. They were supported by a section of the shareholders. On the other hand, a majority of shareholders were in favour of closing down. The company is therefore to be wound up, and the assets distributed.

Malaya.—The output of gold in the Federated Malay States during 1919 was £63,559, par value; nearly the whole of it came from the Raub mine, Pahang. The output of tungsten concentrates was 436 tons, about equally wolfram and scheelite; most of it came from Selangor.

Canada.—It is reported that the International Nickel Company, of New York, has purchased the copper properties at Flin Flon lake, north of The Pas, Manitoba. It had been generally understood that Messrs. Hayden, Stone & Co. were in treaty for these properties, but the deal evidently fell through.

The nickel-copper smelter of the British American Nickel Corporation, at Nickelton, near Sudbury, commenced operations on January 17.

Before the war the Associated Gold Mines of Western Australia acquired an option on the Keeley silver mines at South Lorrain, near Cobalt. The business was undertaken on the recommendation of Dr. J. Mackintosh Bell, and his opinion was confirmed by Messrs. Edward Hooper and E. T. McCarthy, who visited the property in 1914. Nothing could be done with the mines during the war, and it is only recently that the matter has been taken up again. A company has now been registered, called the Keeley Silver Mines, Ltd., with a capital of £170,000 in 10s. shares. The purchase price will be £80,000 in shares, and £40,000 is being provided as working capital by the issue of 80,000 shares at par. The new company also acquires an option on the adjoining Beaver Lake property. We may remind readers that Dr. Bell described the South Lorrain district in the Magazine for February, 1914.

United States.—The official estimates of the production of gold and silver during 1919 are given in the following table :

	Gold $	Silver Oz.
Alaska	9.036.300	1.072,137
Arizona	[illegible]	[illegible]
California	17,380 000	1,204.004
Colorado	9,736 400	6,044,911
Idaho	710,400	6.042 016
Michigan	—	375,284
Missouri	100	59 160
Montana	2,461.700	14,940.527
Nevada	4,754.600	7,312,454
New Mexico	595,700	712,791
Oregon	1 071,800	223,578
Philippine Islands	826,100	14 392
South Dakota	5,267 600	122.164
Tennessee	5,300	93.087
Texas	1,100	540,239
Utah	2.152,700	11,906,152
Washington	309.800	316 028
Totals	58,488,800	55,285,196

These totals show decreases of $10,157,900 and 12,524,943 oz. as compared with 1918, and decreases of $25,261,900 and 16,455,166 oz. as compared with 1917.

Further trouble has arisen between Minerals Separation and Butte & Superior. The former has proved that the latter infringed the less-than-1% patent during an injunction of the court, from February to May of last year. Judge Bourquin has accordingly issued an order to show cause why Butte & Superior should not be punished for contempt.

Mexico.—The successful results of development at the El Bordo group of silver mines, recently acquired by the Santa Gertrudis Company on a profit-sharing basis, is reflected by the fact that the milling capacity is to be doubled from 30,000 tons per month to 60,000 tons. By the end of the current year the El Bordo group will be able to supply 40,000 tons of ore per month. The monthly contribution from the Santa Gertrudis mine will then be reduced from 30,000 tons to 20,000 tons. The company also announces the taking of an option on the Espiritu Santo property, in the same district.

The chairman of the Exploration Company, Mr. R. T. Bayliss, has been a consistent pessimist with regard to Mexico during recent years. His speech read at the shareholders' meeting held this month was couched in much the same vein as regards the present position. He is, however, hopeful that, after the next American presidential election, the people of the United States will vigorously demand a participation in the settlement of Mexico. As regards the company's interests in Mexico, the El Oro company is looking for a new property and may call on its parent for financial help. The Santa Rosa mine in Zacatecas is still closed down. The Buena Tierra in Chihuahua has suffered from unwelcome political attentions on the part of Villa's bandits and also from shortness of ore reserves, and work at the mine is now centred on an extended campaign of development in the hope of finding further ore-bodies. The Tomboy and other producing mines in which the company is interested have not been big dividend payers lately, and consequently many shareholders wondered how it came to pass that the profits for the year were so high, permitting of the distribution of a 15% dividend. One shareholder asked whether the profit was due to a successful transaction in Burma Corporation shares, but he was told to come round to the office and ask privately.

At Mexico Mines of El Oro, 130,665 tons of ore was treated during the year ended June 30 last, for a yield of gold worth 1,445,713 United States dollars and silver worth 995,912 dollars. The profit was £196,222, of which £189,000 has been distributed as dividend, being at the rate of 90% free of tax. The company still has a reserve of 379,000 tons averaging $11·60 in gold and 8·6 oz. silver, and development continues to disclose ore. Exploration is being done at new properties in the State of Jalisco.

Siberia.—Last month we mentioned that the Russo-Asiatic Corporation, now in liquidation, had received a demand for the payment of £147,500 for excess profits duty for the year commencing June 30, 1914. Since then the liquidator has received notices of two assessments on account of income tax for the same year. Appeals will be heard shortly.

Brazil.—The Ouro Preto is offering for subscription 25,820 preference shares of £1 each in order to expunge temporary loans and supply funds for the more vigorous development of the Passagem and Santa Anna gold mines. It will be remembered that just before the war arrangements were made for the provision of additional funds with this object in view, and the nominal capital was drastically written down as a preliminary to the issue of new shares. It was not, however, possible to proceed with the plan at the time on account of Treasury restrictions. The present time is opportune for reviving the scheme, for the premium on gold is bringing profits to the company in a way never before experienced. The company also announces that arrangements have been made with Brazilian financiers whereby the latter will do certain development on the Maquiné mine in return for a half interest. This mine used to be worked many years ago, with promising results.

France.—A company called the Var Oil & Coal Company, Limited, has been formed by the Urquhart group to acquire the shares of a French company owning oil-shale and coal deposits in the department of Var, between Cannes and Marseilles. The properties have been reported on by Messrs. Renwick Cowan, Ronald Johnstone, and T. J. Jones. Mr. Jones states that there are two beds of shale outcropping for 1½ miles. One of these has been developed, and its persistence in dip has been proved at various points down to 460 ft. The oil content averages 50 gallons per ton. The reserve already proved is estimated at 1,375,000 tons, and it is proposed to treat 300 tons a day.

Spitsbergen.—The shares of the Northern Exploration Company have been rising again after a fall caused by the acknowledgment of the worthlessness of the iron ore deposit. Vague statements are now prevalent in the city that oil has been found; the company's announcement, however, refers only to gas.

ELECTRICALLY-DRIVEN PUMPS

By WILLIAM LAWS.

The author gives an outline of the principles of electrically-driven pumps, particularly of the centrifugal type, a class of pump increasingly used in mining operations.

INTRODUCTION. — A branch of mechanical engineering which has made great strides of recent years is the development of pumping machinery of all kinds, but particularly of centrifugal pumps, which now, as a result of the co-ordination of practical results and tests with theoretical scientific research are, when manufactured with the skill and experience of our leading engineering firms, highly reliable and efficient machines. Electric drive is becoming increasingly popular for pump work for reasons which will be indicated later, but perhaps it will not be out of place first to say a few words on pumps in general.

CLASSIFICATION.—Pumps may be classified on broad lines as follows: (1) displacement pumps, and (2) centrifugal pumps. The action of a displacement pump consists of definitely displacing a certain quantity of water or other fluid at each impulse, while a centrifugal pump keeps up a continuous definite pressure which causes the fluid to flow in a continuous stream. Displacement pumps may be subdivided into (*a*) reciprocating pumps and (*b*) rotary pumps, and centrifugal pumps may be divided into (*c*) volute pumps and (*d*) turbine pumps; but the difference between these two latter classes, (*c*) and (*d*), is not so marked as between reciprocating pumps and rotary pumps, being rather a difference of construction than one of principle.

HORSE-POWER.—Before definitely fixing the size of motor to drive a pump of any type, the horse-power required by the pump must be known. This will depend on the head, expressed either as a height in feet or as a pressure in pounds per square inch, and also upon the quantity of water to be delivered, expressed in gallons per minute. It will also of course depend upon the efficiency at which the pump and transmission lines are working. The head will include static head and pipe-friction head.

Water horse-power is given by the equation:

$$\text{W.H.P.} = \frac{\text{Gallons per minute} \times 10 \times \text{total head against pump in feet}}{33{,}000}$$

The efficiency of the pump is given by the ratio of the total W.H.P. output to the brake horse-power input.

$$\text{Efficiency} = \frac{\text{W.H.P.}}{\text{B.H.P.}} \times 100$$

SLIP.—Slip, which is a characteristic of the displacement pump, means the difference between the displacement of the pump and the amount of fluid actually discharged expressed as a percentage of the displacement of the pump, thus:

$$\text{Slip} = \frac{\text{Pump displacement} - \text{Volume actually discharged}}{\text{Pump displacement.}} \times 100$$

Slip is caused by leakage past the valves and piston in reciprocating pumps, and past the rotating element and valves in rotary pumps. It may be as little as 2% for a new pump in first-class order, and as much as 50% for an old pump which has been in use for a considerable time. A pump which has been in use for some length of time and has a slip of about 5% or 6% is not doing so badly.

If we neglect slip, the amount of fluid discharged from a displacement pump will vary directly with the speed. This will be quite independent of the head pumped against. The horse-power will also vary with the speed if we neglect the drop in efficiency which occurs when working below normal load.

Let us consider for a moment the case of a displacement pump which is working under constant head, that is, against a constant pressure. Such a pump will require constant torque from the motor driving it, and this will be the case whatever the speed or the quantity discharged. Should the quantity decrease the speed may drop, since the quantity varies directly as the speed. A variable speed motor will therefore be required. To effect the variation in speed in the motor it is most undesirable that power should be consumed in the motor both for reasons of economy and for reasons connected with the heating of the motor. This rules out speed variation by putting resistance in the armature of a direct-current motor or in the rotor of an induction motor. The best method of speed variation is, therefore, by the field regulation of a direct-current motor.

Should the friction head be a material percentage of the total head, the drop in speed of the pump will be accompanied by a material drop in the head pumped against. This is because the frictional head varies as the square of the velocity of the fluid in the channel concerned, so that if the speed is reduced by half the friction head is reduced by a quarter. The torque required will therefore be less.

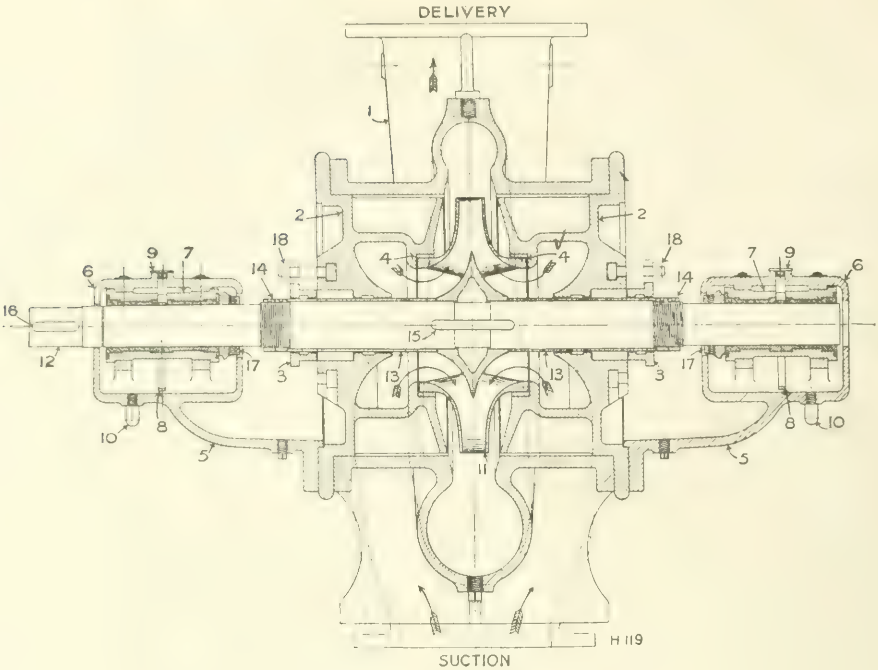


FIG. 1. MATHER & PLATT MEDIUM-LIFT PUMP.

1, Body; 2, End cover (2); 3, Gland (2); 4, Neck ring (2); 5, Bearing body (2); 6, Bearing cap (2); 7, Bearing bush (2); 8, Bearing oil ring (2); 9, Bearing oil lid (2); 10, Bearing oil gauge (2); 11, Impeller; 12, Spindle; 13, Sleeve (2); 14, Nut for sleeve (4); 15, Impeller key (2); 16, Coupling key; 17, Thrust collar (2); 18, Gland bolt (4).

Suppose on the other hand we have a pump running at constant speed. If we neglect small losses we may then say that the torque and horse-power will vary with the head. If then it is desired to start the pump against full working pressure, the motor must exert full load torque, and to do this at start with a squirrel cage alternating circuit motor will entail taking heavy currents from the line, which is by no means a desirable state of affairs. A method of obviating this is to by-pass the pump. The motor can then be run up to speed light, or against a small head which is gradually increased as the motor runs up to speed. When it is running at normal speed the by-pass is closed and the motor picks up its full load.

Although the efficiency of reciprocating pumps, assuming a fairly new pump in good working order, is quite high—about 75% for a 200 ft. head is a typical figure—this fact is largely discounted by the fact that the wear in the reciprocating pump is much greater than in other types owing to the wear in the moving parts, etc.

Most displacement pumps are of the reciprocating pattern. In the smaller sizes they are generally single cylinder, whereas in the larger sizes they are more often triplex. Both types are built in both single and double-acting varieties, or built to discharge either during one stroke per revolution or during both strokes. A double-acting triplex pump has six impulses per revolution. This helps to smooth out the torque curve.

The reciprocating pump finds its peculiar sphere of usefulness in pumping small quantities of water against high heads.

ROTARY PUMPS.—In this type of displacement pump there are two rotating elements which enmesh together something like two gears. In this type slip occurs between the impellers themselves and also between the impellers and the pump casing. From the design of the pump it follows that any wear which may occur in the bearings cannot be remedied by adjusting the moving parts. The most appropriate field for this type of pump is in pumping heavy fluids, such as oil, tar, etc., against low heads.

When electrically driven it is generally necessary to have either gear or belt drive, as their working speed is much below the most suitable motor speed.

CENTRIFUGAL PUMPS. — The general operation of a centrifugal pump is as follows: Water enters the centre of a wheel furnished with curved radial blades. As far as possible it has only radial velocity on entering. As the wheel or impeller is rotated the special shape of the blades causes rotational velocity to be imparted to the water as it passes outwards. Thus a store of kinetic energy is added to whatever energy the water possessed before. The water escapes from the circumferential openings of the impeller into a whirlpool chamber, where its velocity is diminished, and its pressure energy correspondingly increased. The water in the pump will now be able to exert pressure against a head of water against it.

Centrifugal pumps possess the following advantages: They consist essentially of two definite parts, the outer shell or casing in which is included the volute or the diffuser, as the case may be, and the impeller combination consisting of the impeller or impellers mounted on a shaft. The operation is so simple that it does not entail the need of a great deal of experience or any special skill. Should they by any chance go wrong they are generally so constructed that it is easily possible to get at their internals.

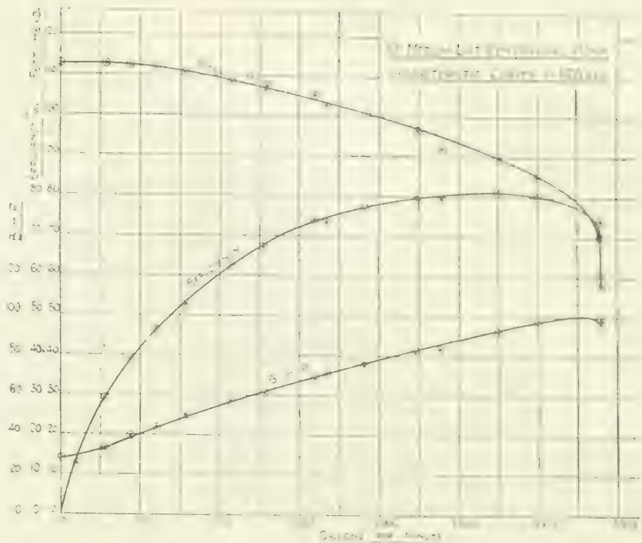


Fig. 2. Characteristic Curves of Medium-Lift Pump.

Whereas the inertia forces to be overcome in a reciprocating pump call for a very sound foundation, the absence of these forces and the smooth balanced running of a centrifugal pump call for only comparatively light foundations. The absence of noise due to the steady torque in one direction is another desirable feature, and also they are easily adapted for direct coupling either to prime movers or to electric motors.

During the last few years it has become customary to build electric motors for higher speeds than heretofore, up to 3,000 r.p.m. This is particularly useful to buyers and makers because the higher the speed the less the cost and size of the pump required. In the selection of a pump for a particular job, there are several factors to be taken into consideration, for instance, the head against which the pump has to work, the quantity of water to be delivered, and the speed at which it is desirable to work. It frequently happens that the head is a constant, so that leaves us with the quantity and speed as the variables. The quantity may be varied either by shortening or lengthening the number of hours during which the pump is working, or by varying the number of units working at one time. There will then be a definite speed which will give maximum efficiency for this head and quantity. The efficiency of the plant may frequently be materially increased by suitably varying the quantity in this manner. The fixed speed of an alternate current induction motor renders it unsuitable for use when it is desired to effect adjustments of this sort. A variable-speed direct-current motor would be more suitable.

Should it happen that a centrifugal pump has to derive its supply from a source on a lower level than the pump it will be necessary to

Fig. 3. Renewable Guide Vane Tips.

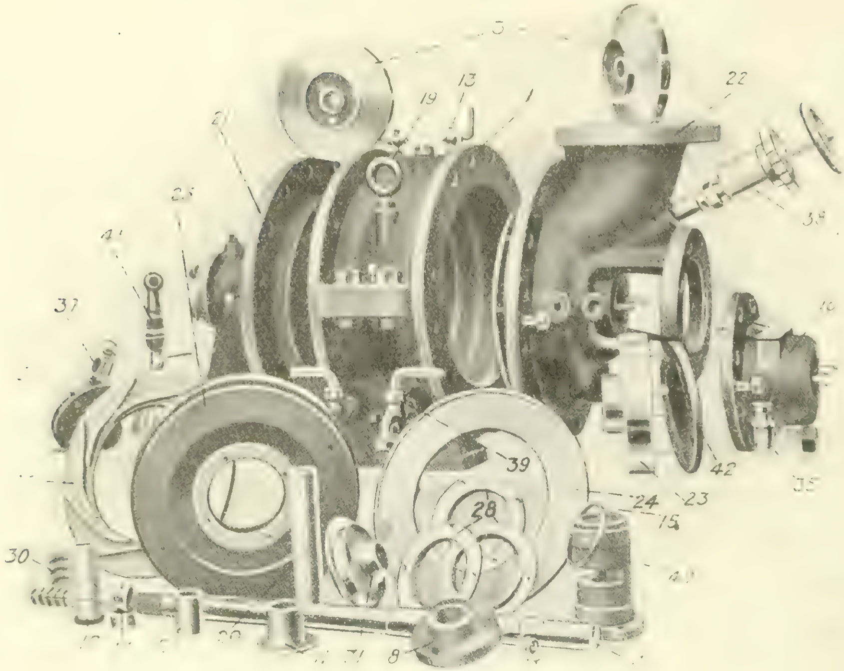


FIG. 4. DRYSDALE TURBINE PUMP DISSECTED.

1, Pump casing; 2, Pump impeller; 4, Pump spindle; 8, Pump gland (driving side); 11, Pump bush (driving side); 12, Pump bush (outer side); 13, Air cocks; 15, Self-oiling rings: 16, Outer bearing; 17, Round nut for spindle: 19, Eyebolts; 21, Suction cover; 22, Delivery cover; 23, Half coupling; 24 Guide plates; 25, Intermediate pieces; 27, Sleeves thro' intermediate piece; 28, Renewable impeller rings: 29, Sleeve thro' delivery cover; 30, Thrust block; 31, Renewable centre piece; 35, Oil overflow pipe; 36, Thrust block cap; 37, Spring-feed lubricator; 38, High-press lubricator; 39, Drain cocks; 40, Outer bearing bush; 41, Funnel and cock; 42, Leather for couplings.

prime or charge the pump before starting. When the pump starts the increase of kinetic energy of the water at the wheel centre causes the pressure energy to fall. The pressure consequently falls below atmospheric and the atmospheric pressure on the surface of the supply forces the water up the suction pipe. Or, in other words, when the pump starts the water at the centre is forced outwards by centrifugal force, consequently there is a tendency to form a vacuum there and water is sucked up into the pump.

For low heads, such as 100 ft. to 150 ft., depending on quantity delivered, the volute type of pump is more usual, whereas the turbine type is more popular for high heads. The difference between these two types lies in the design of the pump casing. In the volute type, as the name would suggest, the discharge opening is in the form of a volute increasing in size toward the discharge pipe. This type is suitable for low heads where the velocity of the water is comparatively low and there is not much loss of power from eddying.

A study of Fig. 1, which shows a typical section of a medium lift pump by Mather & Platt, of Manchester, will illustrate the action of the pump. It will be noticed that the impeller, which is carefully balanced, is of the double suction type, and has similar clearance spaces on either side. This eliminates end thrust and the use of thrust blocks.

Fig. 2 shows the characteristic curves of one of this type of pump. These curves, which are drawn for efficiency, head, and B.H.P. against delivery, show the performance of the pump very clearly. It is evident that the head falls steadily from zero delivery to maximum overload, that the pump works efficiently (over 70% efficiency) over a wide range of delivery, and also that however much below normal the head against the pump be reduced the driving motor can only be overloaded up to a certain amount.

Against greater heads the velocity of water in the pump casing is increased with corresponding loss of power from eddies and churning. To overcome this diffusion, vanes are provided which guide the water in the most efficient way. Fig. 3 illustrates guide vane tips which are part of Messrs. Mather & Platt's high-lift turbine pumps. The areas of the passages and the angle of the vanes are determined by experience and exhaustive research. The addition of these vanes produces the turbine type of centrifugal pump.

Fig. 4 is an illustration of a turbine pump by Drysdale & Co., of Glasgow, dismantled and shows clearly the component parts. A noteworthy feature of this pump is the divided casing which permits of the upper half being removed for inspection purposes without disturbing pipe connections. This convenient arrangement frequently saves dismantling the pump entirely.

PERFORMANCE.—The performance of a centrifugal pump may be said to be governed, speaking generally, by the following: At constant speed the quantity discharged varies inversely as the head pumped against. Also there will be a certain condition of head and discharge which will correspond with maximum efficiency. For any definite speed there is a corresponding maximum head against which the pump can operate. This maximum will generally be rather above the conditions of maximum efficiency which should of course be at the normal working output of the pump.

Now we know that friction losses vary as the square of the velocity. This being the case, there arrives a point when, after increasing the speed by a certain amount to cope with increased head, we find that the friction losses make up too great a percentage of the total losses of the pump. Should it be necessary to work at heads above this point, it is advisable to go for a multi-stage pump. Professor Osborne Reynolds, who was associated with Mather & Platt, invented the multi-stage pump many years ago. The general principle of the pump is to obtain the rise of pressure in the pump in stages. The arrangement is such that water flows from the suction pipe into the eye of the first impeller, and then after discharge from this impeller is led into the eye of the next, and so on until it is finally discharged from the pump altogether. Another way of accomplishing this is by connecting separate pumps in series just as electric batteries are connected in series. If run in series the delivery will be that of one pump while the head will be approximately the total head of all the pumps.

Pumps may also be run in parallel. If run in parallel the head will be that of one pump, while the delivery will be approximately the sum of the deliveries of all the pumps. This is sometimes useful in stations where pumps are required to do different duties at different times, either to lift small quantities against high head, or large quantity against low head, but when the speed of the pumps is of necessity constant, say when driven by alternate-current motors.

Fig. 5 shows the component parts of a Mather & Platt multi-stage high-lift turbine pump viewed from the driving end. In these pumps the impellers are of the single-suction type, and each impeller is keyed to the shaft on its own particular key, ensuring much better fitting than if all the impellers were strung on one common key. This latter method is practically obsolete.

A feature worthy of particular note in these pumps is a very ingenious balance device which

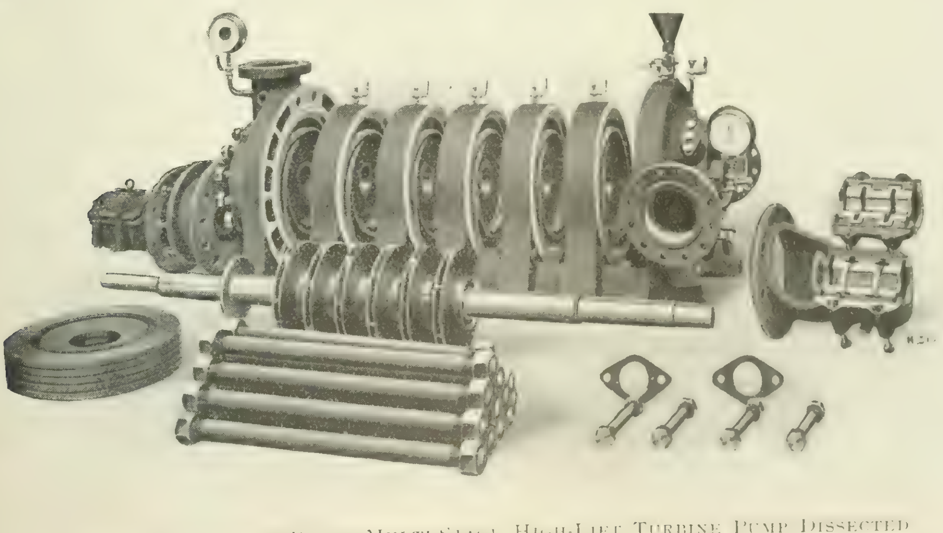


FIG. 5. MATHER & PLATT MULTI-STAGE HIGH-LIFT TURBINE PUMP DISSECTED

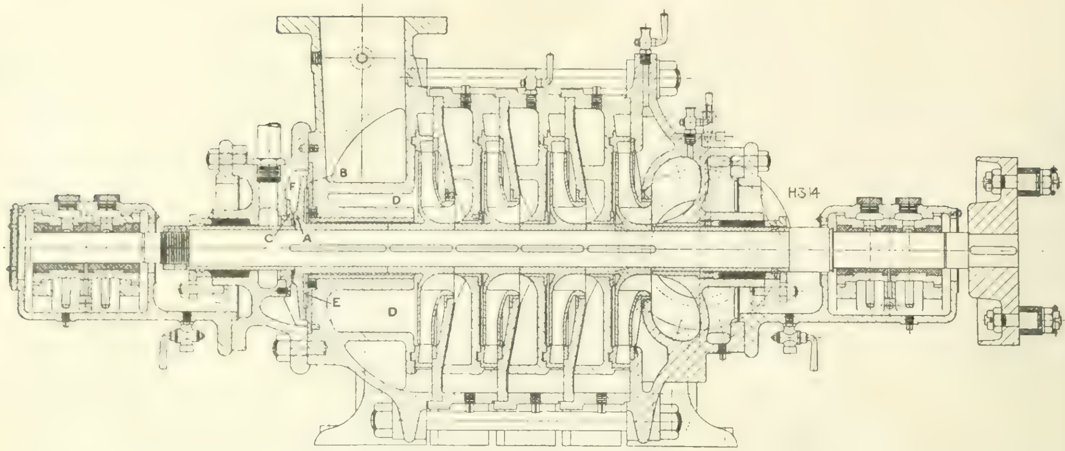


FIG. 6. LONGITUDINAL SECTION OF MATHER & PLATT MULTI-STAGE HIGH-LIFT TURBINE PUMP.

A, Disc or balance valve; B, Large seating (renewable); C, Small seating (renewable); D, High-pressure chamber; E, Intermediate-pressure chamber; F, Low or suction-pressure chamber.

can be best understood from a study of Fig 6. There is a certain pressure on each side of each impeller due to leakage in the clearance spaces. Now although this is nearly the same on each side, yet because single-suction impellers are used, the area subjected to this pressure on the suction side is greater than that on the delivery side. So with a multi-stage pump we have the impeller combination as a whole subjected to a total pressure which is the leakage pressure in the clearance spaces multiplied by the difference in the area of the two faces of each impeller multiplied by the number of stages in the pump. This end thrust has been

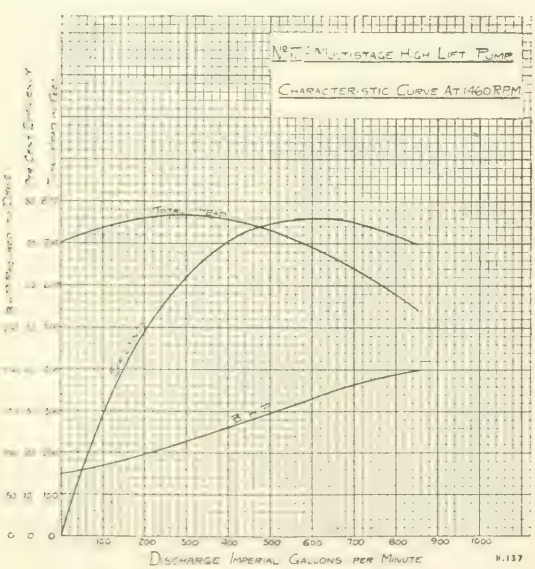


FIG. 7. CHARACTERISTIC CURVES OF MULTI-STAGE HIGH-LIFT PUMP.

known to exceed 10 tons. The mechanical difficulties attending the carrying of this pressure against a thrust block are enormous. After lengthy experiments attended with varying success the automatic disc balancing device came into being about ten years ago which eliminated thrust blocks altogether. The diameter of the balance valve is calculated so that its area when acted upon by the pressure in E (which is the pressure of the last stage of the pump less the loss of pressure due to the flow of the balance water between the hub of the balance valve and the bushing) is much greater than that required to overcome the end thrust due to the impellers. Assume that when the pump is stationary the balance-valve face is bearing on the large seating B. At starting up and as soon as pressure is developed in the pump the balance valve will move towards the small seating C. This movement causes clearance between the balance valve face and the large seating B, resulting in leakage taking place between the balance valve and large seating faces which reduces the pressure in the intermediate pressure chamber E. The balance valve continues to move towards the small seating C and takes up a fixed running position only when the pressure in E is adjusted to the amount required to balance the end thrust of the impellers. In this position the balance valve floats between the large and small seatings and maintains a perfect hydraulic balance. On clear water no wear takes place. On gritty water the wear is not unreasonable.

Fig 7. gives the characteristic curves of a multi-stage high-lift pump by Mather & Platt.

(To be concluded).

THE KWALL FALLS HYDRO-ELECTRIC PLANT

Brief particulars are here given of the hydro-electric plant built for the Northern Nigeria (Bauchi) Tin Mines, Ltd.

TWO years ago an article by Mr. A. R. Canning was published in the Magazine describing the mining enterprise of the Northern Nigeria (Bauchi) Tin Mines, Ltd. It was there mentioned that a scheme was on hand for utilizing the waterfalls on the Kwall River for providing hydro-electric power. This installation is now nearing completion, and a few notes on the subject, together with a sketch plan and a few photographs, will be of interest to our readers.

The problem before Mr. Canning was to obtain a cheaper source of power than the coal or oil which has to be imported, and it was different from that confronting most of the Nigerian mines, seeing that a number of gravel pumps and nozzle pumps are required for breaking and elevating the gravel. It was proposed, therefore, to examine the possibilities of the falls at Kwall on the N'Gel river. In 1918 the hydro-electric department of Vickers, Limited, was consulted with reference to this matter, with a result that the firm sent out an engineer to make a preliminary examination and survey. This engineer returned to England in the autumn of 1918, when the matter was fully discussed, with the result that the technical advice afforded was acted upon, and Vickers, Limited, were instructed to carry out the scheme and to supervise the construction and completion of the whole of the works involved and their satisfactory running when completed, until the new plant should be taken over by the mining company. At the beginning of 1919, Vickers, Limited, sent out engineers to Nigeria and the work was immediately commenced.

The photographs will serve to give a very fair idea of the nature of the country, and the difficulty of dealing with heavy machinery and plant with only the crudest native labour available. It may be here mentioned that the Falls are a succession of small falls and rapids in the course of the river as it plunges down the escarpment of the Plateau. The difference in level over $1\frac{1}{2}$ miles is about 700 ft.

The actual power to be developed in the machinery at present to be installed is not very great, aggregating altogether 1,500 k.w. The alternators will be driven by Pelton wheels working at a total head of about 700 ft. manometric (about 300 lb. per square inch).

The scheme involves a considerable quantity

VIEW NEAR THE BOTTOM OF KWALL FALLS.

A Boulder near Station 1,000 on the Penstock Line, now blasted away.

of difficult work, mainly owing to the wild and rugged character of the country, while it also comprises all the features which are common to a complete hydro-electric development.

The various sections of the work are as follow :

(1). A dam across the N'Gel river above the Kwall Falls.

(2). $1\frac{1}{2}$ miles of canal, cut very largely through rock, from the dam, carrying the water impounded behind the dam to the forebay at the top of the bluff above the power house.

(3). Three steel aqueducts and trestle bridges supporting them, to be used in the line of the canal route when bridging gorges, etc., which it is impossible to fill in without entirely prohibitive cost.

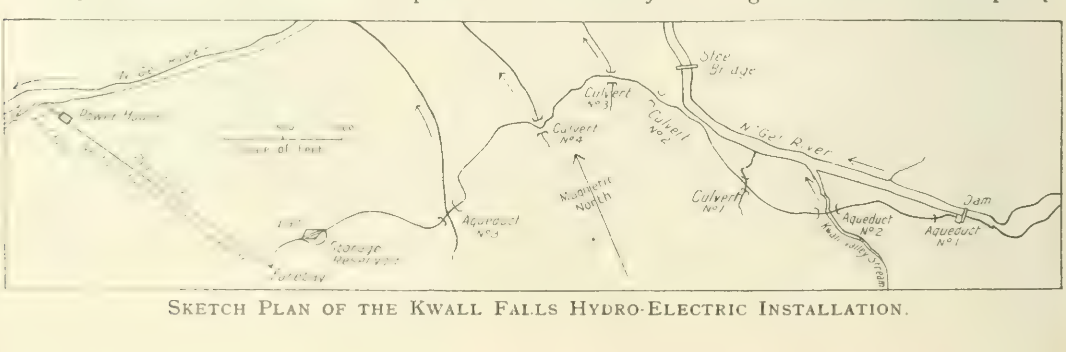
(4). A small storage basin at the end of the canal nearest the forebay, together with the forebay works and the intake to the penstock.

(5). Half-a-mile length of rivetted steel penstock running from the forebay to the power house below on the N'Gel river and falling over 700 ft. when running down that half a mile of incline. This is one of the most difficult pieces of work owing to the steepness of the incline, and the fact that the whole track is covered with huge boulders.

(6). The power house situated on the banks of the N'Gel river containing the turbines, dynamos, switchboard, step-up transformers, lightning arresters, etc.

(7). Fifteen miles of high-tension transmission line at 22,000 volts, 3-phase, 50 cycles, from the power house to the main substation on the mine property.

(8). The main substation on the mine property containing the step-down transformers, 22,000 volts to 525 volts, together with the necessary switch-gear for the various pump-



Sketch Plan of the Kwall Falls Hydro-Electric Installation.

VIEW DOWN CANAL FROM STATION 265.

motor circuits, local lighting, etc.

(9). A subsidiary substation of the same character as in (8), but of smaller capacity, to be used in supplying pumps, etc., from an outlying area.

As has already been mentioned in the Magazine, this scheme, which is the first of its kind in Nigeria, constitutes a tribute to the enterprise and foresight of the directors of the Northern Nigeria (Bauchi) Tin Mines, Ltd., and their consulting engineers, Messrs. C. G. Lush & Son.

VIEW DOWN CANAL FROM NO. 3 CULVERT.

THE LEVANT MINE, CORNWALL

By FRANCIS F. OATS, Assoc.Inst.M.M.

Recently the Levant mine has come prominently before the public owing to the serious disaster that occurred there, and subsequently the reorganization of the operating company under limited liability has renewed interest in the venture. A few remarks about the old mine, written by the engineer, are therefore opportune.

LEVANT MINE is situated on the cliff facing the Atlantic, in the parish of St. Just-in-Penwith, just over six miles north of the Land's End, and about one and a half miles north of Cape Cornwall. The mine has been worked for nearly 100 years, as it was in October, 1820, that it was started by a small local company, with a capital of £400. This company worked the mine until 1872 and made profits amounting to £170,000 during the first 20 years, principally from the production of copper ore, while from 1820 to 1871 the sales of mineral are given as 65,584 tons of copper ore valued at £572,126, and 3,381 tons of tin ore worth £229,847. In 1872 the mine was taken over by the cost-book company now to be liquidated. There were 2,500 shares, and £25,000 was called up for re-equipment. This company has sold 18,578 tons of tin ore for £1,302,130; 70,978 tons of copper ore for £287,177; and 3,800 tons of crude arsenic for £32,657; making a total of £1,621,964 over the 47 years of working.

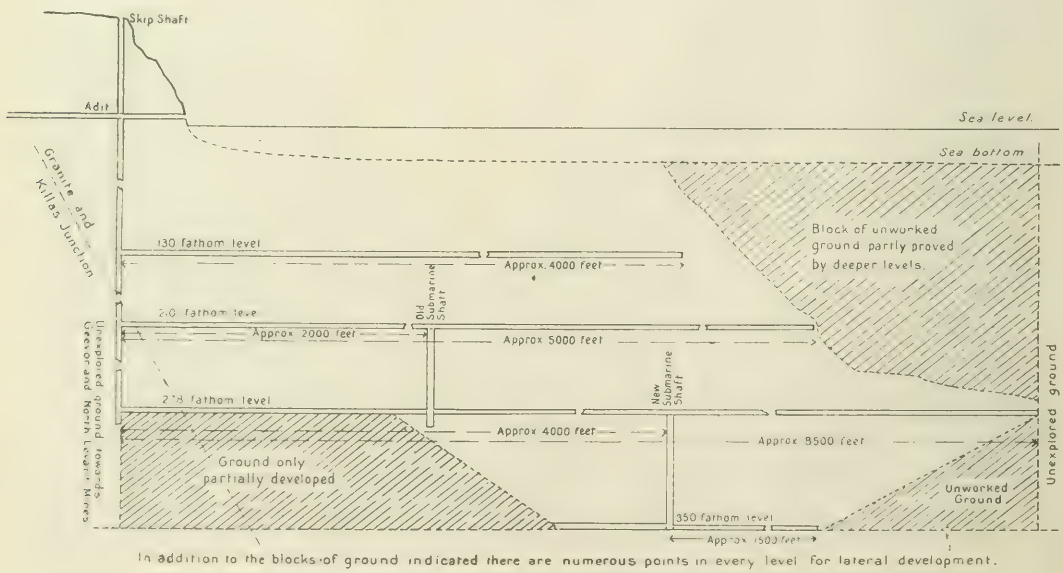
The production for 1916, 1917, and 1918, was as follows:

	Tin Ore		Copper Ore		Crude Arsenic		Total
Year	Tons	Value £	Tons	Value £	Tons	Value £	Value £
1916	437	46,298	155	2,466	202	1,162	49,926
1917	372	48,500	146	2,529	86	2,786	53,815
1918	278	55,171	54	1,782	52	3,184	60,137

The decrease in output is explained partly by the number of men who were withdrawn for the services and partly owing to an unfortunate strike.

Since the accident to the man-engine in October last new leases have been arranged and an agreement made by this cost-book company to hand over the mine to a new limited liability company, with a nominal capital of £160,000 in 320,000 ten-shilling shares; 240,000 of these shares are to be issued at once, and 80,000 are being held in reserve. This new company was registered last month (February) as the "Levant Tin Mines, Ltd."

There are two systems of lodes being worked, the one system having a bearing of about N.W.N. and underlying south, and the other system having a bearing of about N.N.W., and underlying north. These lodes are indicated in the sketch opposite, and it is at their points of intersection that the richest minerals



In addition to the blocks of ground indicated there are numerous points in every level for lateral development.

LONGITUDINAL SECTION OF LEVANT WORKINGS.

have been found. The lodes are in granite in the inland section, but pass into killas or shale before reaching the face of the cliff. The junction of killas and granite is approximately parallel with the cliff and at surface about 150 fathoms inland, but the junction dips toward the sea and at the 278 fm. level is almost under the face of the cliff.

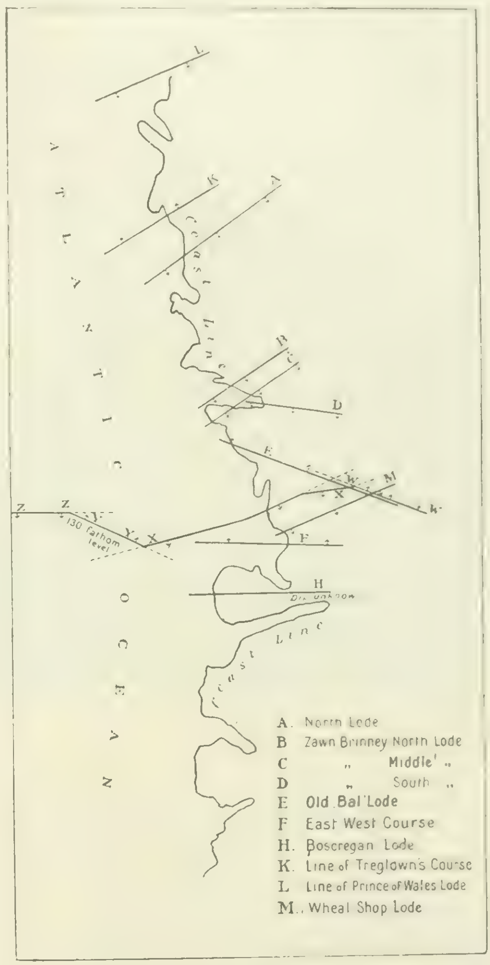
The working of the lodes has been carried on from three shafts sunk in close proximity to one another from the surface on the "Old Bal" lode; but at different depths each of these three shafts has encountered a lode dipping to the south and has been turned on this. From these shafts levels have been driven to the west, the levels above the 130 fm. level having been started west on the "Old Bal" lode which dipped to the north, while below this level, the levels have been started on a lode dipping south.

On all levels junctions have been met, and in almost all cases the level has been continued west on one only of the two lodes forming the junction, while it appears that in many cases the second lode has been forgotten or ignored. So much so was this the case that it was a common belief that Levant lodes were continually changing their direction and underlie. I am not of opinion, from the preliminary examination that I have made since taking over the management on January 1 last, that this is the case, but rather that the levels have been jumped over from one lode to another after the intersections have been made. If this is the case there are very large blocks of ground to be developed in the upper levels as soon as these can be opened up, and very short cross-cuts at proper points will soon prove the correctness or otherwise of this opinion.

In order to explain this argument more clearly I have indicated one level, the 130 fm. level, on the sketch, showing the underlie of the lode in the level at different points by arrows. The parts of the level indicated WW, XX, YY, ZZ, are, I believe, driven on different lodes, and this opinion is formed not only because of the difference in dip and direction but also because of the difference in character of the lodes exposed in the different parts of this level.

The business of proving the extension of these supposed different lodes in the directions marked by dotted lines is not an expensive matter, nor will it take long after the old 130 fm. level has been re-opened and re-made to the different points. What applies to the 130 fm. level applies equally to all other levels that I have had an opportunity of examining, and perhaps to all levels.

In addition to these points there is a large block of ground standing to the west of the



PLAN OF OUTCROPS OF LEVANT LODES, SHOWING ALSO THE 130 FM. LEVEL.

upper levels which has been driven on and practically all stoped for 4,000 ft. in length from the 210 fm. level to the 338 fm. level, while above the 210 fm. level I am not aware of any work being done until lately. At present all the ore being raised in the mine is being got from three lodes above the 210 fm. level, and the average produce from here is over 2% black tin. There is another large section of ground in which very little work has been done below the 210 fm. level and east of the above block of ground.

The explanation for the two blocks of ground having been left lies in the method of working

Photo, R. H. Preston & Sons Penzance.

PANORAMIC VIEW OF

which has been employed in the bottom of the mine. When the 210 fm. level had been pushed out about 2,000 ft. west of "Skip" shaft, rather than sink the latter and drive out under rich ore which was discovered at this point, an underground shaft known as the "Old Submarine" shaft was sunk and the mineral worked both to the east and west of this shaft to about a depth of 300 fm. Before this depth was reached, however, the working at the bottom of this Old Submarine shaft had become too difficult, probably mainly because of ventilation, making it necessary for the Skip shaft to be sunk deeper and a new main level driven west at the 278 fm. level. This 278 fm. level was driven west some 2,000 ft. of Old Submarine shaft, when the same policy was followed and a New Submarine shaft sunk, eventually reaching a depth of 350 fm. Lately the same difficulties as were experienced at the bottom of the Old Submarine shaft have made efficient work impossible.

Finally, there remains plenty of scope for development to the west, where the property has no limits except those of practical mining, and also under the land in the ground adjacent to and west of that being worked by Geevor Tin Mines, Ltd., whose work has proved the value of our lodes in the granite in a way which has been surprising to all who had any experience of the St. Just mining area.

To enable these very large blocks of ground to be worked economically it will be necessary to sink a new shaft and provide new equipment, but meanwhile the old shafts and equipment can be used to keep the mine developing and producing sufficiently to cover all expenses except new work, while it is reasonable to hope that a profit may be made on working.

Since the accident, repair work has been carried out and more men are already at work than was the case at the end of 1918. Sufficient ore is being found to keep the 64 Cornish stamps on the property fully at work, and there is every likelihood of the necessity of an increased stamping plant being required before long.

THE LEVANT MINE, CORNWALL. Photo. R. H. Preston & Sons, Penzance

Steps have already been taken to reduce the surface cost materially, and with modern machinery this could be very greatly decreased.

In spite of the miles of levels under the sea the mine is a dry mine and the water calls for the use of no more than 50 h.p. to keep the mine "in fork." The ventilation is natural and is good, the air throughout the mine being sweet and cool except in such places as the bottom workings, where there is no through draught, and also where the heat generated by the decomposition of sulphides is great.

In conclusion, I believe that this old mine can be rejuvenated, and with anything like the present prices for minerals should respond to the application of the new capital ; in addition it should be possible to pay such wages after the completion of the new shaft as will make it unnecessary for men to seek higher wages abroad. A certain amount of time will, however, be required for the sinking and equipping of the new shaft. I do not consider that it will be necessary to await this shaft being got down to the bottom, but that sufficient ore will be made available in the upper levels to bring it into use very much earlier.

British Columbian Output.

The official figures for the yield of metals and minerals in British Columbia for 1918 and 1919 are given below, the figures for 1919 being estimated.

	1918	1919
Gold, placer ....oz.	16,000	14,325
Gold, lode ....oz.	164,674	141,769
Silver ....oz.	3,498,172	3,667,516
Lead ....lb.	43,899,661	32,134,136
Copper ....lb.	61,483,754	45,984,046
Zinc ....lb.	41,772,916	43,694,583
Coal ....long tons	2,302,245	2,357,218
Coke ....long tons	188,967	98,598

The values of the silver produced were: \$3,215,870 in 1918 and \$3,871,063 in 1919; those of lead \$2,928,107 and \$1,658,121; those of copper \$15,143,449 and \$8,631,205; and those of zinc \$2,899,040 and \$2,717,803.

THE ANALYSIS OF ALUMINIUM,

ITS COMPOUNDS, AND ALLOYS.

By J. E. CLENNELL, B.Sc., Assoc.Inst.M.M.

(Continued from February issue, page 93).

CHAPTER IV.—CONTINUED.

Example No. 7. Reduction of Iron and precipitation of Al by Ammonium Nitrite.

Analysis of Non-Ferrous Alloys, p. 138; Wynkoop, *J. Amer. Chem. Soc. 19*, 434; Schirm, *Chem. Zeit.* (1909), 877.

This method depends on the reactions:

$$AlCl_3 + 3H_2O \rightleftarrows Al(OH)_3 + 3HCl$$
$$HCl + NH_4NO_2 = NH_4Cl + HNO_2$$
$$2HNO_2 = H_2O + NO + NO_2$$

If the solution be acid, very dilute ammonia or ammonium carbonate is added a little at a time with constant stirring till the precipitate formed only just re-dissolves. If a permanent precipitate forms it is re-dissolved in the least quantity of dilute acid. This gives a clear solution of a highly basic chloride of aluminium. A large excess of a 6% solution of ammonium nitrite is now added, the solution largely diluted, and boiled till nitrous fumes are completely expelled. A few drops of ammonia are then added, the precipitate allowed to settle, filtered, washed with hot water, and ignited. It is weighed as Al_2O_3, free from iron.

Example No. 8. Precipitation by means of iodide-iodate mixture.

Ibbotson and Aitchison, loc. cit., p. 138; Stock, *Berichte*, 1900, 548.

This method depends on the reactions:

$$AlCl_3 + 3H_2O \rightleftarrows Al(OH)_3 + 3HCl$$
$$KIO_3 + 5KI + 6HCl = 6KCl + 3I_2 + 3H_2O$$

By means of this mixture the salts of several metals can be hydrolysed, Al in particular.

If the solution is too strongly acid, NaOH is added till a faint precipitate is produced, and this is just re-dissolved in HCl. The iodide-iodate mixture is then added, and the liquid stirred and allowed to stand 5 minutes. The liberated iodine is then removed by adding a 20% sodium thiosulphate solution, then a further small quantity of the iodide-iodate reagent, to ensure complete precipitation. If any colour results, add a drop or two more of the thiosulphate, and allow the mixture to stand on a water-bath for about half an hour. The precipitate of $Al(OH)_3$ may be filtered and washed with comparative rapidity. Ignite and weigh as Al_2O_3.

The reagent consists of equal volumes of a saturated solution of KIO_3 (about 7%) and a 25% solution of KI.

Example No. 9. (Method C 3. Chapter II). Separation of Silicon and Copper in Aluminium Bronze and estimation of Al by Phosphate method.

(Refer to Example No. 1).

This material contains 1 to 12% Al. Dissolve 2 grm. of the alloy in 15 cc. HCl, 5 cc. HNO_3, and 10 cc. H_2SO_4 (conc). Evaporate to fumes of SO_3. Take up residue in water, filter through ashless paper, and wash. The residue contains Si as SiO_2.

In the filtrate remove copper either by H_2S or by thiosulphate or by thiocyanate. Filter, boil to expel excess of H_2S, and apply phosphate method as in Chapter III. without filtering off sulphur if any further amount comes down.

Another method is to electrolyse the nitric acid solution of the alloy, to precipitate copper. In this case the ignited $AlPO_4$ contains some SiO_2, the amount of which is determined, after first weighing the precipitate, by treating with HF and H_2SO_4, again igniting and weighing.

Example No. 10. (Methods A 2, B 1, and C 3 combined). Analysis of Ferro-Aluminium.

Rhead and Sexton, Assaying and Metallurgical Analysis, 1902, p. 363.

Dissolve 0·5 grm. of the finely-divided alloy in concentrated HCl. Evaporate to dryness. Heat the residue with HCl, and filter off insoluble matter (SiO_2, etc.). Wash well with HCl. Nearly neutralize filtrate with ammonia, and add SO_2 until iron is reduced to ferrous condition. Expel excess of SO_2 by boiling. Add a little sodium phosphate and acidify slightly with acetic acid. Heat to boiling. Add 30 cc. of strong ammonium acetate solution and boil 5 minutes. The Al is precipitated, the bulk of the Fe remaining in solution. Allow to settle, wash by decantation, and filter. Dissolve the precipitate by pouring boiling HCl over the filter, collecting the filtrate in the vessel in which precipitation took place. Wash the filter. Transfer solution to a silver dish, evaporate nearly to dryness, add excess of pure NaOH (about 5 grm. made from 3 grm. of pure metallic sodium. This solution should be kept in a gutta-percha or metal bottle to avoid contamination with SiO_2). Volume of solution should not exceed 40 cc.

Stir, boil about 10 minutes, cool, dilute to 50 or 80 cc., filter, and wash. The residue consists of $Fe(OH)_3$, the filtrate contains aluminium, etc. Acidify with HCl, add pure sodium phosphate in excess, make alkaline with ammonia, and boil till the precipitate collects. Settle, decant through filter, wash by decantation, finally transfer to filter, wash free from Cl, dry, ignite, and weigh as $AlPO_4$.

In the case of steel or alloys consisting principally of iron it is necessary to re-dissolve the first acetate precipitate, again reduce with SO_2, and again precipitate with ammonium acetate, to free it entirely from iron.

Example No. 11. Analysis of Ferro Aluminium. (Methods C 2, C 3, and D 4 combined).

Rhead and Sexton, loc. cit., p. 363. Stead's process.

Take 11 grm. of the alloy, add 50 cc. concentrated HCl and evaporate to dryness. Warm residue with 5 cc. concentrated HCl, add 50 cc. boiling water, filter, and wash free from Fe. To the filtrate add a little sodium phosphate, then ammonia till a permanent precipitate is produced, then HCl till this just dissolves, adding the acid drop by drop. Boil, add 50 cc. of saturated sodium thiosulphate, then boil for 1 hour. Filter and wash. Dissolve precipitate in a mixture of 5 cc. concentrated HCl and 5 cc. water, receive solution in platinum dish, and wash filter.

Evaporate, add 5 grm. pure NaOH made from metallic Na (see Example 10). Evaporate to dryness and fuse 10 minutes. Cool, boil out with 50 c.c. water, and make up to 110 cc. (10 cc. = 1 grm. of alloy). Filter, take 100 cc. of the filtrate, neutralize with strong HCl, add 30 cc. saturated sodium thiosulphate, 3 cc. 10% sodium phosphate and a little sodium acetate ; boil a few minutes, filter, wash, dry, ignite, and weigh as $AlPO_4$. The fusion and re-precipitation ensure the complete removal of any iron or manganese carried down by the first precipitate.

In the case of tungsten steel, the tungsten is removed by evaporating the original solution to dryness with nitric acid and filtering. This, however, renders the subsequent reduction with thiosulphate more difficult.

Example No. 12. (Method D 1, Chapter II). Treatment of Mixed Oxides with Concentrated HCl.

Iron and aluminium are precipitated together as hydroxides (as in Examples 1 and 2), ignited and weighed as $Al_2O_3 + Fe_2O_3$. The ignited oxides are then dissolved by prolonged treatment with a mixture of 10 parts concentrated HCl and 1 part water in a covered crucible till the Fe_2O_3 is completely dissolved. If Fe_2O_3 predominates, the solution may be effected in 1 or 2 hours, but if Al_2O_3 predominates the action is often incomplete after long contact, and in this case some fusion method is preferable. The metals are then separated in any suitable way. This may be done as in Examples 3 to 8 inclusive, or by Method F (Chapter II), as follows : Add (say) 10 cc. concentrated H_2SO_4, evaporate to fumes, cool, dilute considerably, heat to boiling and saturate with H_2S (to reduce ferric to ferrous sulphate), filter and pass in CO_2 as the filtrate cools, to remove excess of H_2S. When cold, titrate iron with permanganate, calculate to Fe_2O_3, and deduct from the weight of the combined oxides, to give the amount of Al_2O_3.

Another method is to reduce the HCl solution of the mixed oxides by means of SO_2 and titrate the iron with standard bichromate, calculating as before to Fe_2O_3.

The ignition of the mixed oxides should not be made at too high a temperature. The ignited precipitate is more easily dissolved after very fine grinding in an agate mortar, reweighing after grinding to ascertain if any loss has taken place.

Example No. 13. (Method D 2). Fusion of Mixed Oxides with Alkali Bisulphate.

The ignited mixed oxides of Fe and Al are mixed with 5 times their weight of potassium bisulphate ($KHSO_4$) or 12 to 14 times their weight of of potassium pyrosulphate ($K_2S_2O_7$) and heated until fusion is complete. This may take from 15 minutes to as much as 4 hours: The crucible and cover are then placed in a beaker with water and about 5 cc. concentrated H_2SO_4 added. The melt is dissolved by warming gently. A porcelain crucible may be used ; with a platinum vessel a small amount of the metal always dissolves in this treatment. After removing crucible and cover, reduce as in Example 12, and titrate with permanganate. The author prefers to make this reduction by boiling (say) half an hour with a few sheets of pure aluminium foil, free from iron.

Acid potassium fluoride (HF,KF) may be

used with advantage instead of bisulphate. (Method D 3).

Example No. 14. (Methods A 1, D 2, B 2, combined). Separation of Iron, Aluminium, and Titanium (method of Gooch).

When titanium is present it is precipitated as hydroxide together with Fe and Al by ammonia and similar reagents. The ignited oxides (consisting of Al_2O_3, Fe_2O_3, and TiO_2) are weighed, and then fused with pyrosulphate as in Example 13. The melt is then dissolved in cold water and mixed with 3 times as much tartaric acid as the weight of the combined oxides, saturated with H_2S, and made slightly ammoniacal. Fe is thus precipitated as FeS while Al and Ti remain in solution. The FeS is filtered off, the filtrate acidified with H_2SO_4, heated to boiling, and the precipitate of sulphur and Pt sulphide (if a platinum crucible has been used) filtered off. The filtrate is boiled to expel H_2S, and $2\frac{1}{2}$ times as much permanganate added as the amount of tartaric acid present. SO_2 is then added until the precipitated MnO_2 is re-dissolved, after this a slight excess of ammonia, then 7 to 10 cc. of glacial acetic acid for every 100 cc. of solution, by which titanium is thrown down, leaving the bulk of the Al and Mn in solution. Boil for 1 minute, settle, decant through a filter, wash with 7% acetic acid and finally with hot water. Dry, ignite for 15 to 20 minutes, and weigh. (Impure TiO_2).

The precipitate still contains Al and Mn. Add 3 times its weight of sodium carbonate, and fuse. The melt is coloured green by Mn. Leach with cold water, filter, dry, ignite in a platinum crucible. Fuse residue again with a little sodium carbonate. Cool, dissolve melt in about 2 cc. of sulphuric acid (50 per cent H_2SO_4 by volume), dilute to about 150 to 200 cc. and heat with 5 grm. sodium acetate and $\frac{1}{10}$ its volume of glacial acetic acid. Boil for one minute, settle, filter, wash with 7% acetic acid, then with water, dry, ignite and weigh. This treatment is repeated till constant weight is obtained, which is taken as TiO_2.

Iron is determined in the ferrous sulphide precipitate and calculated to Fe_2O_3, and aluminium is found by deducting the weight of of Fe_2O_3 and TiO_2 from the weight of original ignited precipitate, this giving Al_2O_3.

Example No. 15. (Method D 4). Separation of Chromium from Iron and Aluminium.

If chromium is present as a chromic salt, it will be precipitated together with Fe and Al on adding excess of ammonia. If, however, it exists as an acid salt (chromate or bichromate) it remains in solution and may be separated by filtration. Solutions containing Cr or a chromic salt may be oxidized by adding chlorine or bromine, and sufficient caustic alkali to give strong alkalinity. Iron is thus precipitated as $Fe(OH)_3$ while Al and Cr remain in solution as aluminates and chromates. The mixture is then filtered, the filtrate acidified with HNO_3, and Al precipitated as $Al(OH)_3$ by addition of ammonia, leaving Cr in solution. The precipitate is then filtered, washed, dried, ignited, and weighed as Al_2O_3.

An alternative method is to fuse the mixed ignited oxides (Al, Fe, Cr) with about 6 times their weight of mixed sodium and potassium carbonates, together with a little potassium nitrate, in a platinum dish or crucible. The melt is extracted with water and treated as above.

Example No. 16. (Method D 4. Chapter II). Estimation of Al in Slags and Silicates by Fusion with Alkali and subsequent precipitation with Ammonia.

Rhead and Sexton, loc. cit., pp. 370, 379.

Mix 1 grm. of the finely powdered material with 6 grm. of a mixture of Na_2CO_3 and K_2CO_3 with a little KNO_3, in a platinum dish; fuse for some time in a hot muffle or over blast lamp. After cooling, extract melt with boiling water. Remove crucible and cover, wash these with a little dilute HCl from a wash-bottle, finally dissolve the whole mass cautiously in HCl, covering the vessel to avoid loss. When evolution of CO_2 has ceased, remove cover and evaporate to complete dryness on water-bath. [If evaporated at a higher temperature the mixture will require constant stirring to avoid loss by spirting.] When quite dry, moisten residue with 15 cc. HCl and again evaporate to dryness, finally heating on hot plate, using cover to prevent loss, as the mixture of NaCl and KCl is liable to decrepitate. Moisten with HCl, and again dry. Add 20 cc. HCl, warm, dilute to 150 cc., and filter. [The residue consists of SiO_2. It should be quite white.]

The filtrate contains Al and other bases. It should not exceed 250 cc. Heat to boiling, make faintly alkaline with NH_3, boil, filter. Without washing, re-dissolve the precipitate in HCl, and again precipitate with NH_3, cool, filter, wash, dry, ignite, and weigh as $Fe_2O_3 + Al_2O_3$. If phosphates were originally present, the precipitate also contains P_2O_5. Determine iron and phosphoric acid in separate samples of original material and deduct to obtain Al_2O_3.

The ignited precipitate, after weighing, may also be treated as in Example 13.

Example No. 17. (Method D 5. Chapter II). Separation of Al from Small Quantities of Iron and Phosphoric Acid.

The material is brought into solution by any of the preceding methods that is applicable, the solution precipitated by NH_3, filtered, and the precipitate washed, ignited, and weighed. The ignited precipitate consists of $Fe_2O_3+Al_2O_3+P_2O_5$. Fuse with 6 times its weight of a mixture of 4 parts anhydrous Na_2CO_3 and 1 part SiO_2 over blast lamp. Extract melt with water to which a little ammonium carbônate has been added, and filter. Filtrate contains all the P_2O_5 and a very little SiO_2. Residue contains all the Fe and Al and remainder of SiO_2.

Digest residue in small porcelain crucible with concentrated HCl until $Fe(OH)_3$ is completely dissolved (see Example 12 above). Add sulphuric acid and evaporate to small bulk, then heat over free flame until fumes of SO_3 are evolved. Cool, add water, digest on water-bath for a long time, filter to remove SiO_2, pass H_2S into filtrate to reduce ferric to ferrous iron, remove excess of H_2S, and titrate iron with permanganate.

Evaporate the filtrate containing the P_2O_5 to dryness on water-bath, with addition of HCl, filter, and determine P_2O_5 in filtrate either by the magnesia or by the molybdate method. Al_2O_3 is found by difference.

Where large amounts of Fe and P_2O_5 are present, it is preferable to divide the solution into 3 aliquot parts. In one determine the combined weight of $Al_2O_3+Fe_2O_3+P_2O_5$ by precipitation with ammonia, filtering, washing, and igniting; in a second portion determine iron by permanganate titration or otherwise; and in the third, P_2O_5 by the molybdate method.

Example No. 18. Separation of Fe and Al by Reduction in Hydrogen.

Rhead and Sexton, loc. cit., p. 380.

Transfer the weighed precipitate of $Fe_2O_3+Al_2O_3$ to a porcelain boat and heat in a current of pure hydrogen. The ferric oxide is reduced thus:

$$Fe_2O_3+6H=3H_2O+2Fe$$

whereas the Al_2O_3 is unaffected.

$$\text{The loss of weight} \times \frac{159{\cdot}68}{44{\cdot}88} = Fe_2O_3$$

Difference $= Al_2O_3$.

Or the iron in the reduced residue may easily be dissolved in HCl and titrated, and the undissolved residue washed, filtered, ignited and weighed as Al_2O_3.

Example No. 19. (Method E 2. Chapter II). Separation of Aluminium and Zinc by precipitation of ZnS in Acetic Acid Solution.

The alloy (for instance, aluminium bronze) is treated with HCl and HNO_3 and finally boiled down to fumes with H_2SO_4, cooled, diluted, and copper, etc., precipitated by H_2S in hot solution. The filtrate from the copper precipitate is then mixed with a considerable quantity (say 3 to 5 grm.) of sodium acetate, heated to 60°C, saturated with H_2S, and filtered. Zinc is thus completely precipitated as sulphide, while iron and aluminium remain in the filtrate, and are separated by previous methods.

In case manganese is present, it may be separated from Fe and Al by the barium carbonate or basic acetate methods (see Example 2 above).

A formate may be used instead of acetate in the above process (Hampe, *Chem. Zeit. 9* (1885) 543.

Example No. 20. (Method E 3. Chapter II). Separation of Zinc and Aluminium by precipitation of ZnS in Alkaline Solution.

Seligmann and Willott, J.S.C.I (1905) *24* 1278.

Dissolve 0·5 grm. of the alloy in 25 cc. of 25% NaOH; dilute to 300 cc. with boiling water, settle, and decant the clear liquor. Dissolve the residue in HCl and re-precipitate with excess of NaOH. Filter, mix the two filtrates, pass H_2S through this solution till a skin begins to form at the point where the bubbles of gas burst, showing that precipitation of $Al(OH)_3$ has begun. Filter and wash with water containing NH_4Cl and H_2S. Determine Al in the filtrate by previous methods. [Zinc may be determined in the precipitate by dissolving in 8 cc. HCl, adding 5 grm. NH_4Cl and 250 cc. hot water, and titrating with ferrocyanide.]

Example No. 21. (Method E 4). Electrolytic precipitation of Zinc in Alkaline Solution and Determination of Al in the Electrolyte.

Ibbotson and Aitchison, Analysis of Non-Ferrous Alloys (1915), p. 213.

Dissolve 1 gr. of the alloy in HCl, boil to remove excess of acid, dilute to 60 cc., add strong NaOH till the precipitate re-dissolves with the exception of $Fe(OH_3)$, that is, until further addition of NaOH no longer reduces the turbidity. Filter, wash with hot water. Re-dissolve precipitate in a little HCl and repeat treatment with strong NaOH. Combine the two filtrates, make up to about 300 cc. Electrolyse with c.d. 0·8 and e.m.f. 4 volts. The platinum cathode must be covered with a thin layer of copper before making the deposition. Deposition should be finished in 4 hours (test liquor with Na_2S). Remove cathode, dry, and weigh. Increase of weight is the amount of zinc.

After removal of electrodes, make up volume of electrolyte to 1,000 cc., take out 100 cc. (=100 mgr. of original alloy). Acidify this portion with HCl, add 1 or 2 cc. in excess. Dilute to not less than 300 cc. Heat to boiling. Add 2 grm. sodium phosphate. When just boiling, add gradually 10 grm. sodium thiosulphate, then 5 cc. of ammonium acetate. Boil for about 20 minutes. Filter through a paper pulp, and wash with hot water containing a trace of ammonium phosphate, finally with pure hot water. Ignite precipitate gently at mouth of muffle. Re-dissolve residue in HCl and filter off any SiO_2, etc. Dilute solution to 150 cc. Neutralize with ammonia until a turbidity appears, then just remove this with HCl, leaving a very slight excess. Boil, add 2 grm. sodium thiosulphate. Filter off precipitate, wash, dry, ignite gently, and weigh as $AlPO_4$.

The ferrocyanide titration of zinc in presence of aluminium is not accurate.

Chapter V.

Volumetric Methods for Estimation of Aluminium.

(Sutton, Volumetric Analysis, 10th Edition, 1911, p. 148.)

Three methods are described, which may be defined as follows:

(1) Indirect phosphate method.
(2) Acidimetric method.
(3) Iodimetric method.

Indirect Phosphate Method.

In absence of iron, the acid solution is mixed with a tolerable quantity of sodium acetate, then with a known volume, in excess, of $\frac{N}{10}$ phosphate solution (containing 20·9 grm. ammonio-sodic phosphate per litre). Heat to boiling without filtering. The excess of phosphate is then found by standard uranium solution in the ordinary way, with ferrocyanide indicator. The difference between the amount of phosphate added and found represents that precipitated as $AlPO_4$.

When iron is present it is determined in a separate portion, and the amount deducted in calculating the aluminium, since the precipitate consists of $AlPO_4 + FePO_4$.

1 cc. of $\frac{N}{10}$ phosphate $= 0·00513$ grm. Al_2O_3.

Sutton states that this method is only available for rough purposes.

Acidimetric Method.

Several modifications of this have been proposed, depending on the different ways in which soluble aluminates react toward different indicators.

(*a*) Original form, proposed by Baeyer. A measured quantity of the solution is first treated with sufficient normal caustic soda to re-dissolve the precipitate of hydroxide $Al(OH)_3$ first formed. It is then diluted to a definite volume; one-half is titrated with normal acid and litmus, the other half with normal acid and tropœolin 00. The difference of the two titrations corresponds to the alumina present. The aluminate acts as an alkali toward the first indicator, but is neutral to the second.

(*b*) Modification using phenol-phthalein. This is carried out in the same manner as the above, substituting phenol-phthalein for tropœolin 00. When normal acid and alkali are used, the difference of the two titrations $\times 0·01716 =$ grm. Al_2O_3.

This assumes the reactions:

$$(i)\ 2H_2SO_4 + 2NaAlO_2 = 2NaHSO_4 + 2HAlO_2$$

representing the stage during which solution becomes neutral to phenol-phthalein.

$$(ii)\ 3H_2SO_4 + 2HAlO_2 = Al_2(SO_4)_3 + 4H_2O$$

representing the stage when solution becomes neutral to litmus, and indicating the changes occurring in the interval between the phenol-phthalein reaction (disappearance of pink colour) and the litmus reaction (appearance of red colour).

The titration must take place in cold and dilute solution. Said to be suitable for potash and ammonia alums and for commercial aluminium sulphate.

(*c*) Modification using phenol-phthalein and methyl orange. This is the same as above, but methyl orange is substituted for litmus. The end-point is somewhat sharper, and the stage at which it occurs appears to be different, the factor for alumina, using normal solutions, being 0·0205, pointing to the salt $2Al_2O_3, 5SO_3$ as being formed in the interval between neutrality to phenol-phthalein and neutrality to methyl

orange. The reaction (*ii*) would therefore be:
$5H_2SO_4 + 4HAlO_2 = 2Al_2O_3, 5SO_3 + 7H_2O$

(*d*) Author's modification. The writer has made a number of experiments on the last described method, and has found the following modification to give somewhat more reliable results. A sufficient quantity of the alloy (say 1 grm.) is dissolved in HCl, or $HCl + HNO_3$, and if Fe is present, caustic soda is added until the precipitate first formed has re-dissolved, with exception of $Fe(OH)_3$. The mixture is then, without filtering, made up to 1,000 cc., and allowed to settle. Portions of 100 cc., representing 100 mgs. of the original, are drawn off with a pipette for each titration. Each of these is placed in a suitable flask or beaker, and HCl is added till the precipitate first formed just re-dissolves, and the liquid is cooled if necessary. Methyl orange (one or two drops of a 0·1% aqueous solution) is then added, and $\frac{N}{2}$ caustic soda run in until the pink colour just disappears. The reading is then taken, as the initial point of the titration; phenol-phthalein (a few drops of a 0·5% alcoholic solution) is then added, and titration with $\frac{N}{2}$ soda continued until the pink tint is permanent. This is the final point of the titration. The interval between the two points represents alumina. Neither point is absolutely sharp, and the method can only be considered suitable for rough technical work, but it is rapid and the manipulations are very simple. The order of the reactions of method (*c*) is reversed, as the titration is made with standard alkali instead of acid.

Iodimetric Method. (A. Stock).

The reagents required are:

(1) A mixture of equal parts 25% solution of potassium iodide and a saturated solution of potassium iodate containing 6 to 7% of the salt.

(2) Standard sodium thiosulphate (20%).

The reaction is:

$$Al_2(SO_4)_3 + 5KI + KIO_3 + 3H_2O = 2Al(OH)_3 + 3K_2SO_4 + 3I_2.$$

The reaction commences rapidly in the cold, but is not complete for some days, especially in dilute solutions. The rapidity is increased if the liberated iodine is removed by standard thiosulphate, especially when warmed. By heating the solution on a water-bath the reaction is complete in a few minutes, even in very dilute solutions. The method is not available in presence of tartaric, oxalic, or phosphoric acids, but boric acid does not interfere.

The procedure recommended is as follows: Neutralize with caustic soda as nearly as possible. Add some of the iodide-iodate reagent. After five minutes, run in thiosulphate from a burette till the solution is decolorized, then a further quantity of the iodide-iodate reagent to ensure complete precipitation of $Al(OH)_3$. After heating on a water-bath for half an hour, the flocculent precipitate is filtered off and the titration with thiosulphate completed. [A. Stock: *Compt. Rend. 130* [4] 175, and *J.S.C.I.* 1900, *19*, 276.]

(*To be continued*).

LETTERS TO THE EDITOR

West Australian Base Metals.

The Editor:

Sir—In the November issue of your Magazine, on page 289, appears an article under the heading "West Australian Base Metals" wherein reference is made to a memorandum addressed to the State Government by the Mining Association of West Australia dealing with the prohibition of the export of base metal concentrates from Australia. As an illustration of the unfair incidence of Government control as affecting producers, the case is cited by the Mining Association of a parcel of high-grade silver-lead ore containing 67% lead and 20 oz. of silver having been forwarded for treatment to this company, The Broken Hill Associated Smelters Pry., Ltd., at Port Pirie. The assertion is made that the charge made by the smelters for smelting only amounted to about 42% of the value of the metals, and after the costs for mining, bagging, transport, etc., were deducted, the producers found themselves out of pocket, so the mine was closed down.

In fairness to my company it should be pointed out that no such parcel of ore was forwarded to the Associated Smelters at Port Pirie, and the following extract from a letter received by us from the Mining Association of West Australia will speak for itself:

". . . . With a desire to put nothing but proven facts before the State Government for which the statement was primarily prepared, you will understand the dismay with which the Committee, after receipt of your letter, found that the name of the Broken Hill Associated Smelters had been inadvertently ascribed to the return of ore shipped from Onslow. . . . . For this error, which was purely unintentional, I am directed by my Council to offer your company its sincere regrets and to state that you are at liberty to publish this letter if you desire a public acknowledgment thereof. Care will also be taken to correct the mistake before any other copies of the statement are issued by the Association. . . . . "

I should be glad if you will, in your next issue, give space to this communication.

BROKEN HILL ASSOCIATED SMELTERS PROPRIETARY, LTD.
H. L. SHACKELL,
Secretary.

Melbourne, January 13.

Spelling Reform.

The Editor:

Sir—I have received a communication from the Secretary of the American Institute of Mining & Metallurgical Engineers, presenting arguments prepared by one of the members, Mr. W. H. Shockley, in favour of certain so-called reforms in spelling, and also presenting the brief and sane reply of the President and Board of Directors against such reforms. My ballot has been forwarded, voting against the proposals.

Mr. Shockley and the spelling reformers mean well. Their avowed object is to "make our spelling conform better to the pronunciation;" meaning, one must assume, the present pronunciation of our words. In this attempt they are committing a fundamental mistake, for pronunciation would prove an unstable foundation should it be made the base of a reform in the spelling of our grand language.

Present pronunciation is not uniform. At the present time, words are not pronounced alike in different sections of the United States, nor in different counties of Great Britain (to say nothing of Ireland); not the same in Canada as in Australia. For example: *Been* is pronounced *been* in England and *bin* in U.S.A. *Can't*, *again*, *fast*, *last*, *half-past*, *top*, *worry*, *squirrel*, are further illustrations.

Pronunciation is unstable. As Mr. Shockley and the reformers state, the pronunciation of our words has changed in the past, and to my knowledge it is continuing to change at the present time. In New York, for example, words such as *church*, *skirt*, *bird*, *hurt*, *Ernest*, etc., are usually pronounced *choich*, *boid*, (*boweed* might be better), *sko-eet*, *ho-eet*, *Oeenist*, etc., by most New Yorkers. The usual pronunciation was formerly current in that city during my twenty years' residence there. Contrast these with the sounds of the same words as pronounced in Scotland!

It is untrue to assert that "the spoken and not the written word constitutes the language." Both constitute it, excepting among savage and ignorant races where writing and printing are unused. Latin, for example, is practically dead as a spoken language, excepting in the Catholic church and at University functions; but it still exists in the form of innumerable books, documents, and inscriptions. The sounds of spoken words have an existence measurable in fractions of a second, and unless recorded (as by the phonograph) they cease to exist outside our memories. Per contra, written words have at least a visible and permanent existence.

Mr. Shockley rather praises our English language in saying that it is the widest spoken of all. He advocates a "scientific spelling" to increase the spread of the language among foreign nations. It might accomplish that result; but the present limited spelling-reform proposals are the reverse of scientific, proposing that we castrate only a score or so of our words, as a beginning. Scientific reform of spelling would entail changes of a far-reaching and drastic character. For a scientific, phonetic spelling we would first have to agree upon an accepted pronunciation for all our words, a difficulty indeed. The final result would be a language largely new; perhaps with forty letters in its alphabet. The vast collections of books in our public and family libraries would grow obsolete and unread excepting by those also educated in the present English language.

Even now the attention is somewhat distracted when an American reads an average British publication, and vice versa; for the Spelling Reformers have already begun to confuse our common language. Let us beware of Multiplied Spelling creeping into further use under the alias of Simplified Spelling. If changes come, let them come by natural growth, the slower the better. The doubtful advantages offered by the small but noisy Soviet of Spelling Reformers were well expressed to me a dozen years ago by Mr. T. M. Hamilton, then superintendent of the Braden Copper Mine. He remarked: "I like this simplified spelling: you can spell any — — way you please."

Let us pray that our friends Shockley and Skeat will start to boom Esperanto, and let our language alone.

HAROLD ABBOT TITCOMB.

Farmington, Maine,
January 5.

[Mr. Titcomb says that the change of pronunciation of "church" to "choich" has taken place quite recently. Our own recollection is that in 1892, when we first visited New York, the newsboys shouted "final edition of the Evening Woild" at 3 o'clock in the afternoon.—EDITOR.]

NEWS LETTERS.

VICTORIA, B.C.

January 22.

The value of the mineral production of British Columbia for 1919 is expected to show a decrease of over $8,000,000, or about 20% compared with the previous year. Copper and lead each will show a decrease of about 20,000,000 lb., and all other metals with the exception of silver and zinc will show substantial decreases. Silver will show a slight increase and zinc an increase of about 5% over the 1918 production. The actual production of coal will show a slight decrease, but the value of the production will be more, owing to the increase in the price. Coke will show a decrease of about 30%.

A combination of circumstances has contributed to the great decrease in the copper output, but the principal one, of course, has been the uncertainty of the market and the decrease in the price of the metal. At one time during the year the Granby Consolidated Co. was said to have over 8,000,000 lb. of copper on hand. This stock has been considerably reduced. Among the other causes for decrease in production was the closing of the Phœnix mines and Grand Forks smelter, properties of the Granby company, six months earlier than intended, on account of inability to obtain coke, owing to the strike at the Crow's Nest Pass collieries. Between two and three hundred thousand tons of ore were left in the mines on this account. The fire in the converter plant at Anyox also was a factor toward decreased production. The Britannia Mines, Ltd., which increased its output by more than 1,500,000 lb., was the only big copper producer to show an increase. Besides the uncertainty of the market, the lead output suffered from a misunderstanding between the only smelting company operating in the province and the mine-owners. This has been adjusted by the aid of a committee, appointed by the Federal Department of Mines. The decrease in the gold output needs no explanation.

Taking into consideration the decrease in the copper and lead outputs, from which a considerable proportion of the silver production of the province has come in the past, the increase in the silver output is a matter for marked satisfaction. It may be accounted for mainly by the opening of the Dolly Varden and the Premier mines and a number of smaller dry silver-ore mines that have been opened or reopened owing to the high price of the metal. The increased zinc output is also a matter for satisfaction, because the principal producer, the Sullivan mine, which contributed nearly three-quarters of the production, was closed by a strike for several months. The coal production, too, is highly satisfactory, because the Crow's Nest Pass field was closed for four months by a strike. It was this that caused the slump in the coke production.

Looking to the future, the Granby company, the Consolidated company, and the Britannia Mines are all in a position to increase their production materially should the demand for copper warrant it. So everything will depend on the demand for and the price of the metal. The Consolidated company is branching out at mines that it owns and controls, and is placing two 500 ton concentrators on mines on Vancouver Island. The company claims to have solved the treatment of the Sullivan ore, which has held back the production from that mine for some time, by the introduction of wet magnetic removal of the pyrrhotite and subsequent separation of the galena from the blende by preferential flotation. A 600 ton experimental plant has been erected at Trail, and on the working of this plant the first 2,500 ton unit of the 10,000 ton plant that is to be erected at the Sullivan mine will be planned. The company will erect a 2,500 ton concentrator either at Rossland or at Trail to treat the ore from its Rossland mines. Within the last few days the Temiskaming Mines, Ltd., of Ontario, has entered the local field by bonding a large tract of mineral land, at Buttle lake, in the centre of Vancouver Island. The comparatively small amount of work that has been done is said to have disclosed a belt of low-grade copper ore over 600 ft. wide and several miles in length. Should the grade of the ore be satisfactory, the possibilities of the property are enormous. The company will start exploration work at once.

Unless they should get tied up by litigation, which is threatened in both cases, the Premier and the Dolly Varden mines are certain to give a good account of themselves during the present year, and to increase considerably the silver production of the province. There will be a rush to the Salmon River district, and it is likely that other mines will be found, while many of the prospects that are being explored give promise of becoming mines. Operations at Proserpine mountain, in the Cariboo district, by the Mining Corporation of Canada, with a view to opening up a lode-gold mine, are being watched with interest. Some claim that the mother of the Cariboo placer deposits has been found. The ore-body consists of a belt of interstratified quartz and quartzite, the gold being in the quartz only, and it seems probable that the whole will have to be crushed in order to work it commercially. The problem is whether the whole is rich enough to stand the burden of the quartzite.

MELBOURNE.

January 8.

AUSTRALIAN MINING IN 1919.—It will be some weeks before it is possible to give the results of mining here during last year. Only one thing is quite certain, that is, that the record will be a poor one.

The Under-Secretary for Mines in New South Wales has endeavoured to give something of a survey, but this is based merely on the returns for the first eleven months. The gold yield for that period was 58,551 fine oz., or about 25% below that for the corresponding period in 1918. If the December yield is the same as the average for the eleven months (5,323 oz.), this will make the year's total 63,874 oz., which will be the lowest since the first discovery of gold in Australia in 1851, the next lowest having been in 1888. The principal gold mines of the State are in the Cobar district, and there the industry was greatly hampered by lack of water, which cause also seriously interfered with general mining in other parts of the State. With regard to silver, lead, and zinc, the fact that the Broken Hill mines have been shut down by the strike since the beginning of May will sufficiently explain the position, though the companies have since been treating their accumulated stocks of lead and zinc concentrates. The stoppage of supplies of concentrates from the big mines to the Port Pirie smelters had the effect of stopping the smaller outside mines, but later on some of these got going again, encouraged by the higher prices offered. "Although the yield from Yarranderie will probably be disappointing," says Mr. Cambage, "the prospects of the field and its extension are very bright. Several of the older mines have installed concentrating plants and there is a possibility of the erection of smelters on the field. . . . Rich silver-lead ore, some of which carries a high percentage of gold, has been obtained from the Silver Peak mine's Private Lands leases." The output of copper in 1918 was worth £696,580; the estimated value for 1919 is only £180,000, the decreased production being attributed to the low prices ruling early in the year, to the difficulty of selling the product through want of shipping, and the large accumulation of stocks in Australia. Then there came the closing of the Great Cobar mine, followed by that of smaller mines which supplied ore to it. During the last four months, however, the position has considerably improved; the C.S.A. mine started mining and smelting in September, which led to the reopening of other mines. With respect to tin, Mr. Cambage anticipates that the value of the yield will be over £400,000, as compared with £548,876 in 1918. Dredging was interrupted in the New England district by want of water, the drought having been the severest ever experienced; in the Tingha district only four dredges out of twenty-eight were able to carry on for any considerable period, but about Emmaville, where water conservation is better looked after, the effect was less severely felt, and new sluicing areas have been taken up. At Ardlethan, the ore-bodies maintain their values, and in some instances have improved, and the return from the field is expected to be worth £74,000, or about £3,000 less than in 1918. Coal production has been affected, not only by strikes of colliers but also by scarcity of shipping, the maritime strike, and so on, and no attempt is made to estimate the year's output. Mr. Cambage concludes with the remark that "the reasons for the greatly diminished value of the minerals produced during the year are such as it should be possible to overcome during the year 1920." Very hopeful reports continue to come to hand from the Bathurst district, particularly the Hill End district, where Marshall's Hill End company now owns the leases of the Amalgamated Hill End company above the deep-level tunnel, and will own those below that level in the course of a few months when the present tributes have expired. There are large areas of virgin ground hereabouts, ground which for various reasons was not worked in "the good old days," and some rich crushings of gold ore are said to one of the certainties of the near future.

West Australia's gold yield for the year was 734,066 oz., as against 876,510 oz. for 1918. Considering that the Kalgoorlie mines were idle for about three months the comparison suggests what might have been had labour been united and shown some of the "solidarity" of which it boasts so much. The output of minerals other than gold will not be announced for some time; these figures are usually quite a month later than those of gold output. There is great hope that in the near future the Northampton district, which was the earliest mining field in the State, will once again come to the front as a producer of base metals, several rich lead lodes having lately been proved, which has resulted in great activity and the erection of plant and machinery in several places. The smelting difficulty has been partly overcome; but the chief stimulus to the industry came from the removal of export restrictions imposed during the war by the Commonwealth Government, and from arrangements made by local export firms to make advances against ore sent forward and to arrange for its smelting in Europe.

The Victorian gold yield for the year was 135,427 oz., or 23,399 oz. less than in 1918. Mr. A. H. P. Moline, a prominent member of the Victorian Chamber of Mines, and general manager of the Bendigo Amalgamated Goldfields, has "unhesitatingly affirmed" that the rapidity of the decline in gold production has been checked very largely. Let it be hoped that this is correct; there are few clear evidences of it, however. Bendigo's output last year was certainly about 200 oz. better than that of 1918, but it was only 63,115 oz. altogether, whereas in 1909 that field produced 213,681 oz. Last year, too, the calls made were less in amount than in 1918, the figures comparing as £63,258 to £81,606; but only one company (New Golden Fleece) paid a dividend, which amounted to £1,822, and that was one more than was paid in 1918. To that extent the rate of decline at Bendigo would appear to have been arrested, yet the decline for the whole State was 14·7%. The fortunate discovery in the Constellation workings on the South Moon reef gave a fillip to the Amalgamated Goldfields, but Mr. Moline's optimism is hardly warranted by general facts. On the Ballarat field stagnation is everywhere, and the same is more or less true of the other older fields. A new era appears to be opening in the Bright district, and if the dreams of prosperity which come from there periodically are ever realized there will be something interesting to record by this time next year.

Queensland's gold output was only 120,885 oz., as against 133,571 fine oz. for 1918. In every year since 1903, when the yield was 668,546 oz., the output has diminished to its present meagre figure. The highest output for one year was that of 1900, namely, 676,027 oz., which was followed by a fall to 598,382 oz., and increases to 640,463 oz. and 668,546 oz., but with the exception of a passing improvement of less than 250 oz. in 1915, every subsequent year's production has shown a decline. The total gold produced in this State to date has been 19,585,259 oz., its value being £83,192,838.

WESTONIA. — Finality has not yet been reached respecting the method to be adopted to cope with the water trouble at the Edna May group of gold mines, which has for so long hampered operations, and at present seems to threaten the very existence of the remaining mines of the group. After disbursing £325,660 in dividends, equal to £7. 12s. each on shares paid up to 10s., the parent (Edna May) company reached the end of its tether and the directors decided to remove to another district. The pumps continued to run, as agreed to with the Edna May Central; then the Minister for Mines decided that some steps were necessary to protect the general interest, and the State Parliament promptly passed a Bill empowering him to intervene. Professor Whitfield, of the Perth University, and Mr. Blatchford, assistant mining engineer in the Department, were despatched to examine the district and advise as to the necessary steps. A scheme of co-operation in treatment of material and in defraying the costs of pumping was put forward, but this appears not to have commended itself to the various managements. An alternative scheme advocated an amalgamation of the three principal remaining mines, the Central, the Deep Levels, and the Consolidated, and this has received the general sanction of their managers, though the boards of directors have not approved of it. Of the three mines mentioned only two are now working, the Consolidated having been stopped by the Mines Inspector on account of the insecurity of its shaft. A few days ago, and since the Government undertook to superintend pumping operations, the Central struck a heavy flow of water at the 420 ft. level, but the fissure was at once sealed by the cementation process. In other respects the property was developing well in both the eastern and the western sections, and the company was breaking out ore in stopes in the Consolidated mine on which that company was unable to operate. The Deep Levels mine was also showing satisfactory prospects and was hoping shortly to find the lode from the Central mine. But there was no great readiness to resort to amalgamation of the three interests, even after Professor Whitfield's alternative scheme was put forward, until greater publicity was given to its details. In framing his proposal Professor Whitfield pointed out that a great deal of money might have been saved if, at the outset, a conjoint scheme to control the water had been adopted. The Edna May company, he says, has spent probably £25,000 on its pumping plant, as well as £1,000 monthly for four or five years on actual pumping. The Deep Levels has also spent thousands of pounds in pumping plant and further thousands in cementing, and the Central has been spending about £1,000 a month in pumping. The Deep Levels has a block of ore locked up from operations, estimated to carry perhaps £40,000 worth of gold. The total loss and expenditure in combating the water he puts down at £150,000, whereas an efficient pumping station with high-lift centrifugals would not have cost more than £20,000, and would have pumped the whole of the water for about £500 per month, making a total expenditure of about £50,000. So that the mining industry in the district has been penalized to the extent of something like £100,000. He suggests that it may be necessary for the Government to amend the Mining Act by providing for the formation of a water board to devise a scheme of co-operative pumping whenever a group of mines is faced with the prospect of water troubles. Meantime, he suggests, the remaining mines would all benefit greatly by an amalgamation of interests. The publicity given to this suggestion immediately elicited from a prominent member of the Melbourne Stock Exchange, Mr. A. Rutter Clarke, an usually interesting letter in which he not only supports the proposed amalgamation, but also declares that the board of the original Edna May company erred grievously at the outset in not taking up the adjacent blocks and making one big enterprise of the whole area. It may be easy to see that now; but, at the first, the formation and general conditions were so unusual that many men well-qualified to judge were dubious as to even the one proposition turning out trumps. Mr. Clarke, however, says that at that time a director of the Edna May company told him that they had sufficient gold in their own mine, without troubling about adjacent blocks, the fallacy of which, he says, is shown by the fact that, although that property proved immensely rich, it has already cut out. Mr. Clarke's letter met with a most cordial reception among members of the Stock Exchange on the day of its publication. Whether it will assist in bringing about the suggested amalgamation of the Central, Deep Levels, and Consolidated companies is a different question. As already stated, the managers of those companies support the proposal; the directors have shown no similar disposition up to the time of writing.

VICTORIA'S BROWN COAL DEPOSITS.—Thanks largely to the disastrous effects upon Victorian industries of recent industrial troubles in New South Wales and of the interstate shipping strike, there is at last some prospect of something being done to make use of the enormous deposits of brown coal at Morwell for the production of electric current for various purposes, as well as in the manufacture of briquettes. The possibility of so employing them has, of course, been recognized for many years, and a series of reports have been made on the subject, after which things were allowed to go on as usual, except that during the last couple of years a small quantity of the coal has been extracted for use as fuel. Used in that form the brown coal has had to fight its way against many disadvantages, such as the absence of suitable furnaces, or the high cost of making the necessary structural alterations during the war period, while Government apathy infected factory owners to a considerable extent. The result was that it was only when coal supplies from New South Wales were cut off by strikes that the precarious position of Victorian industry was adequately recognized. Toward the end of November the electricity commission appointed about a year ago sent in its complete report, and the Government lost no time in putting this before Parliament and taking the necessary preliminary steps towards giving it effect. The commission's scope was to investigate the comparative merits of three electrical propositions, namely, to employ (1) the Morwell brown coal, (2) Altona brown coal, (3) hydraulic power derived from the Kiewa River watershed, in the north-east of the State. In their report they show no hesitation in recommending the first-named, at any rate as the first instalment of a more general scheme which may be developed in years to come. Both at Morwell and at Altona the supplies of brown coal are practically inexhaustible. Altona has the advantage of being quite close to Melbourne (almost "at the back door"), but its coal would have to be got by tunnelling; Morwell, although 80 miles from Melbourne, has the advantage of easy working conditions, the whole available deposit being workable by quarrying or open-cut, and offering sufficient coal to produce up to 100,000 k.w. regularly for 150 years. At one portion of the field, within a radius of a mile around the site on which it is proposed to erect the power station, boring has proved the existence of 150,000,000 tons, and it is estimated that this can be extracted and delivered at the power house at a cost of 2s. 2½d. per ton, based on an output of 2,000 tons per 8-hour day, and on a capital expenditure of £221,000. The claims of the Altona field are not overlooked, neither is the fact that a London syndicate is prepared to come forward with a capital of £2,000,000 to work it and to supply electric current all over the metropolis; but the Government is not disposed to part with a monopoly in this matter, and it is almost certain that, when the Morwell scheme has been completed, the existing rights of the Melbourne City Council and the Melbourne Electric Supply Company will be absorbed by the Government. The total expenditure on the scheme is estimated at £2,516,392 for an output of 50,000 k.w., but this will be increased to about £3,000,000 by the erection of dwellings and the provision of mining plant and a briquetting plant. This question of briquetting has been under consideration for several years, and there is not a shadow of doubt that, had it been permitted for any outsider to take up the industry, this useful form of fuel would have been on the market some few years ago. This, however, was not allowed; the Government insisted on holding its own property for its own control, but did nothing. Certainly, it erected a small experimental plant in one of the northern suburbs, but nothing was ever heard of its doings unless some member of Parliament asked a question, when the usual reply was that the experiments were proceeding. It is noticeable that in the new proposed scheme also the briquetting plant, to be installed at Morwell at a cost of £30,000, is described as an experimental plant with a capacity of 70 tons per day, though sufficient experience should by now have been accumulated to furnish a very advanced point d'appui.

TORONTO.

February 12.

PORCUPINE.—If the present activity in gold production continues throughout the year the output will considerably exceed that of 1919. Labour conditions show some improvement, but the supply remains short of the demand. In anticipation of the annual report of the Hollinger Consolidated, which will shortly be issued, it is stated that it will show a reduction in operating costs during 1919 to \$4·41 per ton, as compared with \$4·95 in 1918. The ore reserves will show a small decrease, the volume of ore extracted being nearly equalled by that developed. The underground development done amounted to about 25,611 ft., in addition to some 37,000 ft. of diamond-drilling. The output, close upon \$7,000,000, marks a new high record. The Dome Mines is rapidly extending its 1,150 ft. level into the adjoining Dome Extension property. It has been found by cross-cutting that the ore-body on the two properties is on a slope continuing into the Extension for some distance. As the option held by the Dome expires next month, there is considerable speculation as to whether it will be exercised, or an extension of time asked for. At the McIntyre three levels have been opened up below 1,000 ft., at 1,125, 1,250, and 1,375 ft. respectively, encountering a good grade of ore. The shaft has reached a depth of 1,560 ft. Another main haulage level is being established at 1,375 ft. and preparations are being made for stoping ore found below the 1,000 ft. level. Operations on the Plenaurum have been seriously interfered with by water, which renders it likely that the option held by the McIntyre on that property will be dropped. The Dome Lake mill is in operation, treating about 60 tons per day. A shipment of bullion was made last week. The Clifton Porcupine has begun lateral work on the 200 ft. level, driving on an ore-body which shows visible gold, and is cross-cutting to tap several veins which showed good gold content on the 100 ft. level. At the Davidson a deposit of rich ore has been encountered at the 500 ft. level, reported to be 32 ft. wide.

KIRKLAND LAKE.—This camp is exciting much interest among investors and some new enterprises are being undertaken. The rich finds at the Kirkland Lake mine have been proved by development to be larger in volume than was previously known. Driving on the 400, 500, 600, and 700 ft. levels shows high gold content at varying widths. The Lake Shore during December treated 975 tons of ore with a production of \$14,637. The mine has now been completely unwatered. The annual statement shows a deficit of over \$47,000, owing to the suspension of operations caused by the strike. The Tough Oakes also sustained a loss during 1919, to the amount of \$105,934, the mine having remained closed down for the winter. Col. H. H. Johnson, the manager, who was at last accounts in Rhodesia, is expected to return in the spring when operations will be resumed. The Lebel-Crystal Lake Gold Mines, Ltd., a new company capitalized at \$3,000,000, has acquired 18 claims with a total acreage of 800 acres in Lebel Township, where the formation is similar to the gold-producing zone. Development will be undertaken early in the spring. The Wood-Kirkland, another recently-organized company, has taken up 300 acres south of Mud Lake in Lebel Township, and will begin work shortly. At the Ontario-Kirkland a 6 ft. vein carrying \$20 to the ton has been opened up for 100 ft. on the 300 ft. level. Two other veins showing good gold content have been cut and a large amount of milling ore developed.

COBALT.—Under the stimulus given to the production of silver by the high price of the metal, and the probability of its continuing to remain at its present level for some time to come, activity in the silver field is steadily maintained. The Trethewey has sold its Cobalt mine to the Coniagas for $100,000 cash, reserving the right to remove the machinery for the development of its Gowganda property on which the company will concentrate its activities. The Beaver, in exploring undeveloped ground, has encountered a large body of milling ore, 6 to 10 ft. wide, with wall-rock impregnated with native silver on the 530 and 400 ft. levels. The annual statement of the Crown Reserve indicates that the company has considerably improved its position. Ore production was valued at $223,034, an increase of some $25,000 over that of 1918. Mining and other expenses were $35,000 less than in 1918, and the balance at the credit of the mining and operating account was $77,230. Profit and loss account showed a surplus of $601,684. The Adanac is proving a disappointment, diamond-drilling in the area between the underground workings and the Temiskaming boundary having led to no discoveries. The mine has some good milling ore, but its finances are reported at a low ebb. The Dickson Creek Co., operating north of Haileybury, has encountered several low-grade veins on the 150 ft. level. The shaft will be put down to the 350 ft. level to explore the vein system at the contact between the conglomerate and diabase formations. Protracted litigation over the Bailey mine has been brought to a close by a judgment of the Appeal Court directing the liquidators to accept the offer of A. J. Young to purchase the mine and organize a new company which will also own the Northern Customs Concentrator. The Peterson Lake has sold 400,000 shares, realizing sufficient funds to carry out extensive exploration plans.

GOWGANDA.—The Trethewey has completed 100 ft. of driving on its R.C. 101 claim at the 108 ft. level, the vein maintaining its width and high grade throughout. The North Cliff, a new company, has taken over a group of claims one-and-a-half miles west of Gowganda townsite, containing about 100 acres. The plan of development comprises the driving of a tunnel into a high ridge, where a vein series has been uncovered on the surface. The shaft on the Bonsall Six is being unwatered and sampling will be undertaken.

BOSTON CREEK.—The shaft of the Boston-McCrea is down 800 ft. and driving at this level has encountered an ore-body of good width, stated to carry $8 to the ton. The Kennedy-Boston has sunk a shaft 85 ft. on a vein which has widened out considerably and shows coarse gold. Driving will be proceeded with at the 100 ft. level. At the Charette a good width of commercial ore is stated to have been struck in diamond-drilling.

CAMBORNE.

GRENVILLE.—The statutory report of the new company discloses the fact that out of the 400,000 shares of 5s. each constituting the capital, the number issued is 348,167, so that the new money available is not so much as was anticipated would be the case. Fortunately the price of tin has come to the rescue, and at the statutory meeting the Chairman was able to state that costs other than development were more than being met out of revenue, and that the surplus would help to eke out the capital which is available for development. Exploration work will be confined to the upper levels for the present, and it is satisfactory to learn that the company's technical advisers are of the opinion that indications point to the existence there of considerable bodies of payable ore. The monthly returns, as judged by the Ticketing sales, are steadily improving, and we have some confidence that, with vigorous development, this improvement will continue. Doubtless it is reasonable to anticipate that in the near future the company will sell its black tin production by private contract, and so lessen the returning charges.

TINCROFT.—The report and accounts for the year ended December 31 last have been issued with commendable promptitude, and other Cornish mining companies might, with advantage, follow the lead given by Tincroft in this respect. The loss for the year is heavy, as was anticipated, £17,483, including £1,598 for depreciation, but it is so far satisfactory to learn that approximately only one-fifth of this loss was made in the second six months. We are glad to see that the sequence of half-yearly figures has been maintained, and that the omission to hold the summer meeting of shareholders had no ill effect in this respect. Below we give a summary of the results:

	Six months ended June 30, 1919.	Six months ended December 31, 1919.
Lode stuff crushed.........tons	20,895	15,849
Black tin sold...............tons	171	144
Produce per ton...............lb	18·32	20·3
Value of black tin sold	£21,792	£22,943
Average price per ton	£127	£160
Average per ton of ore.........	20s. 10·3d.	28s. 11·42d
Total receipts per ton of ore	30s. 2·61d.	43s. 9·10d.
Total working costs..........do.	42s. 1·74d.	48s. 0·95d.
Loss ....do.	11s. 11·13d.	4s. 3·85d.

It is satisfactory to hear that the mine is now being worked at a small monthly profit, but if the demand for higher wages, referred to later, is granted, it will be a long time before the debit of £13,107 on the profit and loss account is wiped out. The development for the year was only 1,575 ft., which compares with 3,805 ft. in the previous year, and this serious curtailment was, of course, made to lessen the loss. But for the vigorous development of the South lode during the war, the existence of the mine would have been seriously jeopardized last year, and there can be no doubt that any profits now being made should be devoted to the continued development of this lode, on which the future of the mine mainly depends. We hope the employees of the company will have the good sense to realize this, and not follow the advice of Mr. Joe Terrett, to squeeze the company for substantially higher wages, until the development position has been righted.

APPLICATION FOR INCREASED WAGES.—The Dockers and Workers Unions have made an application to the Employers Federation for the following rates of pay, to be antedated as from July 1, 1919:

UNDERGROUND.	Not less than:
Rock-drillers	15s. per shift
Stopers	13s. 6d. „ „
All other class of underground work	12s. 6d. „ „
Youths under 18 years of age	25s. per week on starting
do. after 12 months' experience	30s. „ ..

In the case of afternoon and night shifts, five shifts to count as six. All hours worked beyond ordinary shifts to be paid at overtime rates, namely, time and a half on week-days and double time on Sundays and Bank Holidays.

SURFACE	
Mechanics	1s. 8d. per hour
Engine drivers	1s. 6d. per hour
All other workers (men)	1s. 4d. per hour
Women	30s. per week
Girls under 18 years of age	20s. per week
Boys starting at 14 years of age	18s. per week
Boys at present employed	Extra 5s. per week

These surface rates to be paid on the basis of a six-day week of 44 hours, excepting shift workers, whose hours shall be 48 unless dependent on underground workers, when underground shifts shall be deemed the week's work. Overtime as in case of underground workers.

It is quite obvious that the mines, until there has been a recovery from the losses of the past year, cannot entertain any such substantial claims, although we hope and believe, in view of the lessened purchasing power of the sovereign, that means will be found to grant some increase on present rates. If only the men would work harder and increase the output, the rate of pay could readily be raised, but this is a side of the problem on which the Unions do not welcome discussion. Why is it that the output per man of the Cornish miner in foreign fields is so much higher than in Cornwall under conditions which are comparable?

We cannot help thinking that this demand, unreasonable under the existing condition of the industry, has been hastened and fixed high largely to offset the criticism of Mr. Joe Terrett, who is trying to induce the men to join the Metalliferous Miners Union (referred to in the last issue), and who, in the hearing of the writer, claimed that the other Unions had been remiss in not pressing for an increase before. When the financial condition of some of the mines, notably Dolcoath, Tincroft, and Grenville, is considered, it is obvious that without Government assistance (which is most unlikely), or increased output, substantially higher wages cannot be paid. The early publication of the 1919 accounts of the principal companies would be a good move for the enlightenment of both the employees and the public.

LEVANT ACCIDENT.—The official report of Mr. H. A. Abbott (one of H.M. Inspectors of Mines) on the circumstances attending the breakage of the Levant man-engine last October, has now been published. He attributes the cause of the disaster to the fracture of one of the caps attaching the man-engine rod to the engine at surface, and this fracture was the result of a local defect in the metal of the cap, caused probably by insufficient application of the method of hammering, filing, reheating, and rolling of the iron in the process of manufacturing the bar from which the cap was cut. The defect was of such a nature as could not be detected by external examination.

MINERS AND FOOD PRICES.—The miners of St. Just and also of the Camborne-Redruth area are on the warpath against the high price of butter and other commodities, and demonstrations have been organized by way of protest. At Redruth there were very disorderly scenes, caused by the younger element, as a result, and the butter stalls were raided and the contents stolen. There can be no doubt that the farmers have been too grasping, and the exasperation of the people, as expressed in this way, may help them to decide to curtail their profits. On the other hand, the disinclination of people here to eat any margarine and to demand only butter is unreasonable and selfish, and, if carried out in all the country districts, must result in the townspeople getting practically no butter at all.

PERSONAL

E. C. ANDREWS has been appointed Government Geologist for New South Wales in succession to J. E. Carne. In 1898 he went to Fiji to study coral reefs. Since 1899 he has been connected with the N.S.W. Geological Survey. He has written on the molybdenite resources of the State, and on the geology of Cobar. For the last year or so he has been engaged in an examination of the Broken Hill district.

R. A. ARCHBOLD is home from Nigeria.

PHILIP ARGALL is visiting Australia and New Zealand.

C. A. BANKS has left London on his return to British Columbia.

G. W. CAMPION is home from West Africa.

A. A. DAVIDSON has left for Nigeria.

H. S. EMLAW has been appointed general manager for the American Trona Corporation in California, and R. W. MUMFORD chemical engineer at Searles Lake.

J. C. FARRANT is expected back from the United States this month.

ROWLAND C. FEILDING has left for Canada.

H. GEMMELL is back from Siberia.

E. HOWARD GREIG has returned to the Bawdwin mines, Burma, from Australia.

E. M. HAMILTON is at El Oro, Mexico, advising the Mexico Mines as regards metallurgical treatment.

E. MACKAY HERIOT has been appointed manager of the Pena copper mines, Southern Spain.

LOFTUS HILLS has been appointed Government Geologist for Tasmania in succession to the late W. H. Twelvetrees. He served for 3½ years in the mining corps attached to the Australian Expeditionary Forces in Europe. Last month he received the degree of D.Sc. from the Hobart University.

E. J. HORWOOD, works manager for the Broken Hill Proprietary at Broken Hill, has been transferred to the Melbourne office of the company.

C. J. INDER, of the firm of Inder, Henderson, & Dixon, has returned from the properties of the British Platinum & Gold Corporation in Colombia.

R. C. JENNINGS is returning from West Africa.

J. V. LAKE has returned from Nicaragua to Australia, and his address is now at Ballarat.

J. DYER LEWIS has been elected president of the South Wales Institute of Engineers. He has for many years been one of the Government Inspectors of Mines.

WALDEMAR LINDGREN has been elected president of the Mining and Metallurgical Society of America.

GERALD LOVELL has been appointed a director of the Burma Corporation, Ltd., recently formed under Indian law.

E. A. LORING is back from the United States.

E. T. McCARTHY has joined the directorate of the Ipoh Tin Dredging, in the place of H. D. GRIFFITHS, who has resigned, as he expects to remain indefinitely in Burma.

J. D. MILLEN and A. D. MACKAY, lately manager and assistant manager at Mt. Bischoff, have entered into partnership as consulting engineers, with offices in Melbourne.

W. A. NOYES has been elected president of the American Chemical Society.

R. D. OLDHAM has been elected president of the Geological Society.

E. J. RICHES has left for Southern Nigeria.

F. S. SQUIRE is in South Africa on business for Hadfields, Ltd., of Sheffield.

W. C. STEPHENS, managing director of the Climax Rock Drill and Engineering Works, Ltd., is in South Africa.

I. A. STIGAND has left for Canada.

B. B. THAYER, vice-president of the Anaconda Co., has gone to South America to inspect the company's properties there.

G. GORDON THOMAS has been appointed manager for the Jos Tin Area (Nigeria), Ltd., and is now at the mine.

HOWARD T. WALSH has been elected a vice-president of the Sullivan Machinery Company.

W. WHYTE has resigned from the Messina mine and is returning to England.

JAMES WICKETT, of Redruth, is visiting Portugal and will afterwards go to the Riviera on holiday.

CHARLES WILL WRIGHT has returned to Italy from a brief visit to the United States, and has opened an office, together with Louis A. Wright, at 28 Via Parlamento, Rome.

EDWARD BRUSH, vice-president of the American Smelting & Refining Co., died on January 6.

HENRY G. TURNER, a pioneer of manganese production in Southern India, died last month. He was originally a member of the Indian Civil Service, but recognizing the high commercial value of the manganese deposits, left the Government service and devoted himself to their development. Subsequently he turned his attention to the magnesite deposits, with equal success. He was a fine type of Englishman, tall and handsome, and a keen sportsman.

CHARLES DUFF LESLIE, lately consulting engineer to the Consolidated Gold Fields, was killed in a railway accident at Fortuna, Transvaal, last month. He was born in Scotland in 1871, and in 1889 went to South Africa. He was in the Natal Civil Service from 1890 to 1895, and subsequently took up mining and geological work. He was at various mines belonging to the Gold Fields, and eventually was appointed superintending engineer to the group. Two years ago he succeeded H. H. Webb as consulting engineer, a position which he resigned in December last.

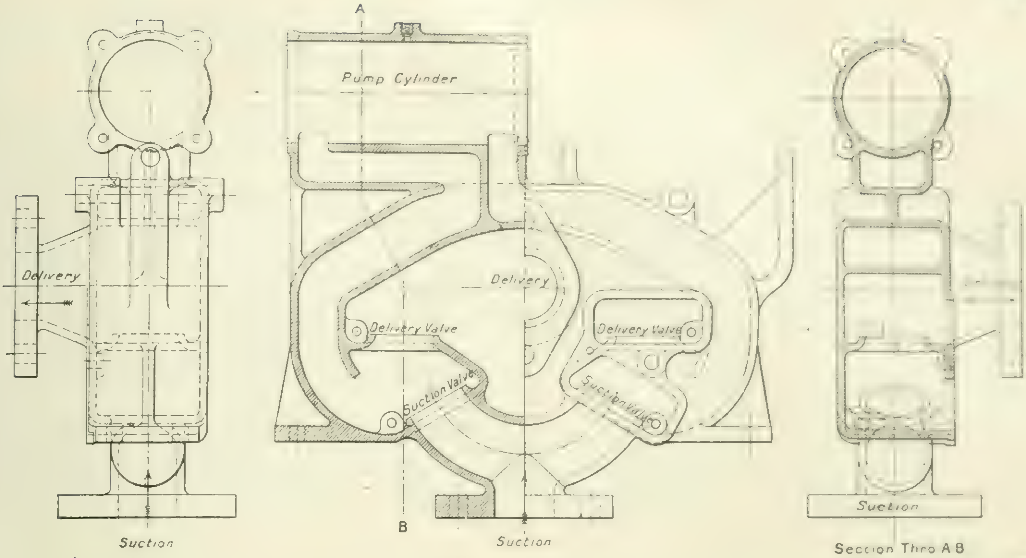
ROBERT ETHERIDGE, a distinguished son of a distinguished father, died at Sydney on January 4, in his 74th year. In early days he was a member of the Victorian Geological Survey, but came back to join the Scottish Survey. With his father he helped in the transfer of the geological collections from the British Museum to the new Natural History Museum at South Kensington. During this time he continued to study Australian geology, and with Dr. Logan Jack wrote the classic on the geology of Queensland and Papua. In 1887 he went again to Australia, and the remainder of his life was devoted to the study of its geology. As Professor Edgeworth David has said, the classification and correlation of the coalfields, goldfields, artesian water basins, oilfields, and other mineral deposits of the Commonwealth are based essentially on his work. His name is perpetuated in many places, a town in Queensland, a peak in New South Wales, and a glacier in Antarctica having been called after him.

TRADE PARAGRAPHS

THE HARDINGE CONICAL MILL CO., of Denver, New York, and London, announce a change of name to the HARDINGE COMPANY.

THE WORTHINGTON PUMP & MACHINERY CORPORATION, of 115, Broadway, New York, has issued a comprehensive catalogue of condensing apparatus.

MARSHALL, SONS & CO., LTD., of Gainsborough, send us a catalogue of steam engines. The firm's engines are in demand for pumping and winding installations, and for electric generating plant.

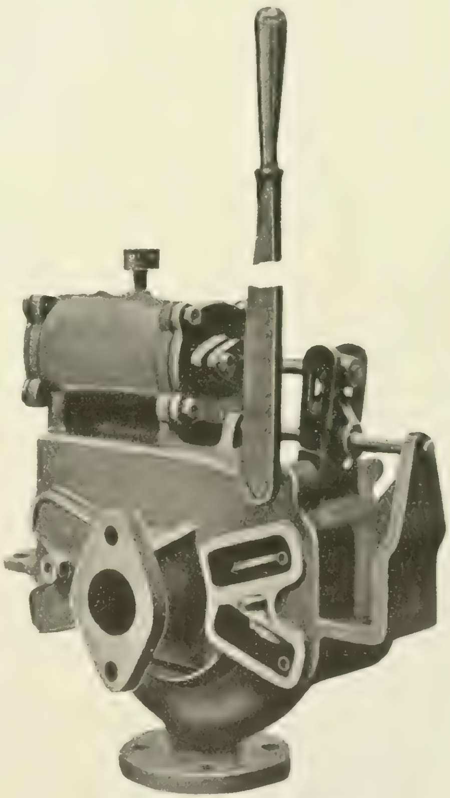


THE FINNEY PUMP IN SECTION AND ELEVATION.

T. COOKE & SONS, LTD., of York, and 3 Broadway, London, S.W.1, send us their pamphlets relating to the new "Rand Model" mining theodolite, and an improved miner's compass or dipping needle, the latter being designed by Professor Henry Louis.

JOHN & EDWIN WRIGHT, LTD., Universal Works, Birmingham, have a representative show at the British Industries Fair now being held at Birmingham, including haulage and winding ropes and ropes for aerial cable-ways. The firm have recently sold much steel rope for oil-drilling operations.

THE ENGINEERING SUPPLIES CO., of 24, Grey Street, Newcastle-on-Tyne, and of 20, High Holborn, London, W.C., have recently put on the market a pump which is the invention of their senior partner, J. W. Finney. It is of the reciprocating piston type, but obviates all contact between the fluid to be pumped and the working parts, with the exception of the inlet and discharge valves. In other words, the piston does not come into direct contact with the fluid, the cylinder being quite dry. The pump is double-acting and all the valves and also the discharge are all arranged below the cylinder. The illustration shows a 2 in. hand pump. It will be seen that each end of the cylinder communicates by means of a passage with a separate valve chamber. These passages are so constructed that the cubic contents are equal to so many cylinder volumes. When the piston is moved through a full stroke, a volume of air equal to the capacity of the cylinder flows into it from the corresponding passage way. This movement releases an equal volume of air from the valve chamber, creating the necessary vacuum in its chamber and permitting the atmosphere to lift the water, which is expelled on the return stroke. The volume of air released from the valve chamber as described rises into the water passage and, combined with the air in the cylinder, acts as a cushion between the suction water and the piston, thus preventing the water rising into the cylinder. It is this air which expels the water on the return stroke of the piston. A similar operation takes place on the opposite side of the pump, the combined discharge of both sides being received by a central chamber and delivered at the side outlet. It is a feature of this movement that the volumetric efficiency is considerably increased thereby, due to a "boosting" effect caused by the velocity of the suction water on the one side and the movement of the



THE FINNEY HAND PUMP

DAILY LONDON METAL PRICES: OFFICIAL CLOSING
Copper, Lead, Zinc, and Tin per Long

	Copper				
	Standard Cash	Standard (3 mos)	Electrolytic Ingots	Electrolytic Wire-Bars	Best Selected
Feb.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
11	120 5 0 to 120 10 0	122 5 0 to 122 10 0	128 0 0 to 132 0 0	130 0 0 to 132 0 0	127 0 0 to 129 0 0
12	119 15 0 to 120 0 0	122 0 0 to 122 5 0	127 0 0 to 131 0 0	129 0 0 to 131 0 0	127 0 0 to 129 0 0
13	119 10 0 to 119 15 0	121 17 6 to 122 0 0	127 10 0 to 130 10 0	128 10 0 to 130 0 0	126 0 0 to 128 0 0
16	118 5 0 to 118 10 0	120 15 0 to 121 0 0	127 0 0 to 130 0 0	128 0 0 to 130 0 0	126 0 0 to 128 0 0
17	119 10 0 to 119 15 0	122 0 0 to 122 5 0	127 0 0 to 130 0 0	128 0 0 to 130 0 0	126 0 0 to 128 0 0
18	119 5 0 to 119 10 0	121 15 0 to 122 0 0	127 0 0 to 130 0 0	128 0 0 to 130 0 0	126 0 0 to 128 0 0
19	119 10 0 to 119 15 0	122 0 0 to 122 5 0	127 0 0 to 130 0 0	128 0 0 to 130 0 0	126 0 0 to 128 0 0
20	119 10 0 to 119 15 0	122 5 0 to 122 10 0	127 0 0 to 130 0 0	128 0 0 to 130 0 0	126 0 0 to 128 0 0
23	120 10 0 to 120 15 0	123 0 0 to 123 5 0	128 0 0 to 131 0 0	129 0 0 to 131 0 0	126 0 0 to 128 0 0
24	121 0 0 to 121 5 0	123 12 6 to 123 15 0	128 0 0 to 131 0 0	129 0 0 to 131 0 0	127 0 0 to 128 0 0
25	122 0 0 to 122 5 0	124 10 0 to 124 15 0	128 0 0 to 131 0 0	129 0 0 to 131 0 0	127 0 0 to 128 0 0
26	121 15 0 to 122 0 0	124 5 0 to 124 10 0	128 0 0 to 131 0 0	128 0 0 to 131 0 0	127 0 0 to 128 0 0
27	120 5 0 to 120 10 0	122 15 0 to 123 0 0	128 0 0 to 130 0 0	128 0 0 to 130 0 0	126 0 0 to 128 0 0
March					
1	120 5 0 to 120 10 0	122 15 0 to 123 0 0	128 0 0 to 130 0 0	128 0 0 to 130 0 0	126 0 0 to 128 0 0
2	119 7 6 to 119 10 0	122 7 6 to 122 10 0	127 0 0 to 129 0 0	127 0 0 to 129 0 0	126 10 0 to 128 0 0
3	118 15 0 to 119 0 0	121 15 0 to 122 0 0	127 0 0 to 129 0 0	127 0 0 to 129 0 0	126 0 0 to 128 0 0
4	116 15 0 to 117 0 0	120 5 0 to 120 10 0	127 0 0 to 129 0 0	127 0 0 to 129 0 0	126 0 0 to 128 0 0
5	114 5 0 to 114 10 0	117 15 0 to 118 0 0	122 0 0 to 126 0 0	122 0 0 to 126 0 0	122 0 0 to 124 0 0
8	111 15 0 to 112 0 0	115 5 0 to 115 10 0	121 0 0 to 124 0 0	121 0 0 to 124 0 0	122 0 0 to 124 0 0
9	105 15 0 to 106 0 0	109 0 0 to 109 5 0	120 0 0 to 124 0 0	120 0 0 to 124 0 0	119 0 0 to 121 0 0

piston on the other. The increase is very considerable and of high economic value. The mechanical efficiency is equally high. In the hand pumps the feature of the dry cylinder exists so long as the pump is operating within the limits of the barometer, that is, 28 to 30 ft., combined suction and delivery or suction only. Outside these limits the pumps can be used with considerable advantage for all usual pumping purposes, but the virtue of the dry cylinder is lost and this it is most desirable to retain when gritty or corrosive liquids are being dealt with. The makers are now engaged on the production of these pumps for heavy duties, outside the range of hand-power, and driven by steam, electric or petrol motors, compressed air, or by belt. These pumps are adapted for mining work, and especially for draining working faces,and in metallurgy for moving gritty and corrosive liquid.

FRASER & CHALMERS ENGINEERING WORKS (proprietors, the General Electric Co., Ltd.), 67, Queen Victoria Street, London, E.C.4., and Erith, Kent, have issued a new catalogue dealing with the conveying and transporting of material. It is a bulky catalogue and contains descriptions of a great variety of plant for many different purposes.

Last month we wrongly stated that THERMIT, LTD., had absorbed the CONTINUOUS REACTION CO., LTD. The facts are that Thermit, Ltd., have moved their head office to that of the Continuous Reaction Co., Ltd., 155, Church Road, Battersea. The latter company are carrying on as before, but are now controlled by Explosives Trades, Ltd., which acquired control of Thermit, Ltd., some months ago.

THE WILFLEY COMPANY, LTD., of Salisbury House, London, E.C.2, are putting on the market a new grinding mill, made under Broadley's patent. The machine is of the short tube-mill type, and has a screen which controls the size of the discharge, with means for returning oversize to the grinding compartment. The material is discharged at the periphery and not through the trunnion, thus securing more rapid evacuation. The screen is arranged in such a way that a "free screening" zone is obtained, thus avoiding the return of such material as would pass the screen by further sifting. The company will send Pamphlet 77 describing the mill, on application.

METAL MARKETS

COPPER.—This market has assumed rather an improved aspect during the past month. Hitherto attention has been diverted from this metal by the phenomenal activity in, and advances in values of, some of the others. Of course the cases were somewhat different, in so far as copper is an article of which there is no world scarcity. The American market has kept very steady at around 19 cents, and it is reported that in view of the business which has been doing there the situation is more healthy than it has been at any time since the Armistice. Of course it should always be borne in mind that production can be increased if the occasion were opportune, but so long as the price is kept at a moderate level this seems less likely to take place. On this side values have tended rather firmer, which is largely due to the adverse exchange conditions increasing the cost of importing the metal. Business with consumers has only been moderate, but there seems to be more inquiry waking up from the Continent. A good demand continues for such manufactured products as copper and yellow metal sheets, plates, etc., but the inquiry for tubes is not very bright.

Average prices of cash standard copper: February 1920, £120. 6s. 2d.; January 1920, £118. 4s. 1d.; February 1919, £78. 10s 3d.; January 1919, £93. 9s. 9d.

TIN.—In spite of the very high level to which this metal had already attained, values have seen a further important advance during the month of February. What makes this perhaps all the more remarkable is the fact that America was not doing much buying in the London market. It seems that there have been rather larger spot stocks in the United States than usual and this had the effect of persuading buyers into deferring purchases. Meanwhile a firm tone prevailed in the East, and values in London showed much strength, it being generally anticipated that America must soon come in as a buyer on an important scale. Rumours were current that there was some syndicate in existence whose object was to support prices. Whether there is any truth in that or not is hard to say, but circumstances have undoubtedly had their own effect apart from any artificial support. Toward the end of the month there was a report that Bolivia intended to put

PRICES ON THE LONDON METAL EXCHANGE.
Tons; Silver per Standard Ounce; Gold per Fine Ounce.

Lead: Soft Foreign	Lead: English	Zinc (Spelter)	Standard Tin: Cash	Standard Tin: 3 mos.	Silver: Cash	Silver: Forward	Gold	
£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.			s. d.	Feb.
49 10 0 to 50 7 6	50 15 0	62 5 0 to 64 5 0	391 15 0 to 392 5 0	392 10 0 to 392 15 0	[illegible]	87½	123 [illegible]	11
49 15 0 to 50 12 6	51 0 0	62 10 0 to 64 2 6	388 10 0 to 389 0 0	389 5 0 to 389 10 [illegible]	[illegible]	[illegible]	120 [illegible]	12
49 15 0 to 50 12 6	51 0 0	61 15 0 to 63 15 0	388 15 0 to 389 0 0	389 10 0 to 389 15 0	[illegible]	79¾	[illegible]	13
50 10 0 to 51 7 6	51 10 0	60 15 0 to 63 0 0	389 0 0 to 389 10 0	390 10 0 to 390 15 [illegible]	[illegible]	81	121 3	16
50 17 6 to 51 10 0	51 15 0	60 15 0 to 61 10 0	391 15 0 to 392 0 0	392 15 0 to 393 0 [illegible]	[illegible]	[illegible]	[illegible] 0	17
51 15 0 to 52 10 0	52 10 0	61 0 0 to 63 7 6	392 5 0 to 392 10 0	393 10 0 to 393 15 0	[illegible]	82	[illegible]	18
52 7 6 to 53 7 6	53 7 6	61 7 6 to 63 17 6	396 0 0 to 396 5 0	397 10 0 to 397 15 [illegible]	[illegible]	[illegible]	121 0	19
52 7 6 to 53 7 6	53 10 0	61 5 0 to 63 15 0	401 0 0 to 401 10 0	402 10 0 to 402 15 0	[illegible]	[illegible]	119 6	20
52 5 0 to 53 2 6	53 5 0	61 10 0 to 63 10 0	410 0 0 to 410 10 0	412 10 0 to 413 0 0	[illegible]	[illegible]	[illegible]	23
52 5 0 to 53 2 6	53 5 0	61 10 0 to 63 10 0	415 10 0 to 416 0 0	418 0 0 to 418 10 0	82	80½	[illegible] 0	24
51 17 6 to 52 15 0	53 0 0	61 5 0 to 63 7 6	418 10 0 to 419 0 0	421 10 0 to 422 0 0	82½	[illegible]	120 8	25
51 7 6 to 52 5 0	53 0 0	61 0 0 to 62 12 6	405 0 0 to 405 10 0	408 0 0 to 408 10 0	82¼	80¾	[illegible] 8	26
51 12 6 to 52 12 6	53 0 0	59 15 0 to 61 10 0	399 0 0 to 400 0 0	402 0 0 to 402 10 0	82¾	82	122 4	27
								March
52 0 0 to 53 7 6	53 10 0	59 5 0 to 61 15 0	403 0 0 to 403 10 0	406 5 0 to 406 10 0	84	[illegible]	121 [illegible]	1
51 10 0 to 53 2 6	53 5 0	59 10 0 to 62 10 0	411 0 0 to 411 10 0	415 10 0 to 416 0 0	[illegible]	[illegible]	119 6	2
49 0 0 to 50 5 0	50 10 0	58 0 0 to 61 5 0	409 10 0 to 410 0 0	412 10 0 to 412 15 0	[illegible]	[illegible]	[illegible] 0	3
47 15 0 to 50 0 0	49 15 0	57 0 0 to 60 10 0	397 10 0 to 398 10 0	403 10 0 to 404 0 0	84	[illegible]	119 0	4
48 0 0 to 50 5 0	50 5 0	56 0 0 to 59 5 0	393 0 0 to 393 10 0	396 5 0 to 396 10 0	[illegible]	[illegible]	114 6	5
50 0 0 to 52 5 0	52 0 0	52 0 0 to 55 10 0	386 0 0 to 386 10 0	390 10 0 to 391 0 0	[illegible]	78¾	115 6	8
50 5 0 to 53 0 0	52 10 0	54 0 0 to 57 10 0	372 0 0 to 372 10 0	376 5 0 to 376 15 0	[illegible]	77½	114 6	9

an export tax on tin. It is understood, however, that the actual intention is to levy a tax on mining profits.

Average prices of cash standard tin: February 1920, £395. 16s. 6d.; January 1920, £376. 12s. 9d.; February 1919, £224. 3s. 5d.; January 1919, £248. 9s. 11d.

LEAD.—There is no particular change in the general aspect of this market beyond the fact that prices are still higher. The position as regards supplies remains as before. The strike at Broken Hill continues, with no prospect of a settlement. Meanwhile the American market is firm, and this reduces the prospects of Mexican lead coming in any volume to this country. Some of that description has been shipped to this country, and some small quantities of Spanish lead have also come in, but these have not been of sufficient importance to affect the position. There seems, of course, to be enough lead about to satisfy most needs, but it is the prospective scarcity that has driven the price up. Business with consumers here has been on a fair scale, while there has also been a good export inquiry.

Average prices of soft pig lead: February 1920, £50. 12s. 9d.; January 1920, £47. 7s. 2d.; February 1919, £26. 13s.; January 1919, £34. 10s.

SPELTER.—Like other metals this also advanced during the month of February, although not to a specially important extent. Values in America have fluctuated slightly, but when the low exchange rate is taken into consideration, it has usually been the case that the cost of importing spelter was well above the level at which it could be bought on the Metal Exchange. This is apparently to be explained by the fact that there were still fair quantities in the hands of dealers and speculators, and the re-selling of these satisfied the demand. So far as America is concerned, producers seem pretty well sold for near delivery, and the tone of the market there seems good. It remains to be seen, however, whether production will not be stimulated at present levels. A very fair business has been moving here with consumers, and there was also some demand for the Continent.

Average prices of spelter: February 1920, £62. 3s. 7d.; January 1920, £59. 10s. 4d.; February 1919. £42. 11s. 6d.; January 1919, £50. 15s. 11d.

ZINC DUST.—The market has shown little variation, the highest grade imported zinc dust being still quoted at £85 per ton,

ANTIMONY.—This article was steady until near the end of the month, when English regulus was raised to £72 per ton.

ARSENIC.—Quiet but firm, at £68 to £70 for white delivered London.

BISMUTH.—The price is unchanged at 12s. 6d. per lb., with a good demand in evidence.

CADMIUM.—6s. 6d. to 6s. 9d. per lb.

ALUMINIUM.—£165 for the home trade, and about £175 for export.

NICKEL.—Steady at £230 for the home trade, and also for export.

COBALT METAL.—10s. 6d. per lb

COBALT OXIDE.—8s. 3d. per lb.

PLATINUM.—Nominal.

PALLADIUM.—£30 nominal per oz.

QUICKSILVER.—The market eased off in the earlier part of the month, but latterly became firmer at about £24. 10s. to £24. 15s. per bottle.

SELENIUM.—10s. to 11s. per lb.

TELLURIUM.—95s. to 100s. per lb.

SULPHATE OF COPPER.—Lower at about £48.

MANGANESE ORES.—4s. per unit c.i.f. U.K. for Indian grades. Supplies are scarce and the demand growing.

TUNGSTEN ORES.—Wolframite 65%, 35s. per unit, and scheelite 65%, 34s. to 35s. per unit.

MOLYBDENITE.—85%, 100s per unit.

SILVER.—The market advanced to 89½d. early in February for spot standard bars, this being the highest price on record. Since then values have been easier, and at the end of the month the quotation was 83½d. for spot standard bars.

GRAPHITE.—80%, £35 to £40 per ton c.i.f. U.K.

CHROME ORES.—(48–50%), £10 per ton c.i.f. U.K.

IRON & STEEL.—The feature of these markets continues to be the stringency in the quantities of material available. For pig iron an excellent inquiry continues both for home and export, but the quantities of metal procurable are insufficient to meet home requirements, to say nothing of the overseas demand. In manufactured the demand also exceeds supply.

STATISTICS.

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand	Elsewhere	Total	Par Value
	Oz.	Oz.	Oz.	£
January, 1919	662,205	13,854	676,059	2,871,718
February	621,188	15,540	636,728	2,704,647
March	694,825	17,554	712,379	3,025,992
April	676,702	18,242	694,944	2,951,936
May	706,158	18,837	724,995	3,079,583
June	682,603	19,776	702,379	2,983,515
July	705,523	19,974	725,497	3,081,713
August	686,717	19,952	706,669	3,001,739
September	680,359	18,199	698,558	2,967,287
October	705,313	18,409	723,722	3,074,174
November	657,845	20,125	677,920	2,879,834
December	631,833	18,358	650,191	2,761,836
Year 1919	8,111,271	218,820	8,330,091	35,383,974
January 1920	653,295	17,208	670,503	

* Not given in the official returns.

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1919	160,599	11,848	3,539	175,986
February 28	172,359	11,868	4,264	188,491
March 31	175,620	11,168	5,080	191,868
April 30	175,267	11,906	5,742	192,915
May 31	173,376	12,232	5,939	191,547
June 30	172,505	12,544	5,831	190,880
July 31	173,613	12,453	5,736	191,802
August 31	170,844	12,450	5,655	188,949
September 30	169,120	12,392	5,294	186,806
October 31	167,499	12,691	4,492	184,682
November 30	164,671	12,565	4,337	181,573
December 31	166,155	12,750	4,271	183,176
January 31, 1920	176,390	12,766	4,796	193,952

COST AND PROFIT ON THE RAND.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 65% of the working profit. Figures based on par value of gold.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1918	24,922,763	27 11	21 7	6 0	7,678,129
January, 1919	1,942,329	28 9	23 0	5 8	547,793
February	1,816,352	28 9	23 2	5 6	498,204
March	2,082,469	28 2	22 6	5 6	573,582
April	1,993,652	28 7	22 9	5 9	573,143
May	2,099,450	28 4	22 3	5 10	608,715
June	2,032,169	28 4	22 4	5 10	592,361
July	2,134,668	27 10	21 9	6 0	611,118
August	2,036,128	28 5	22 11	5 5	551,203
September	2,019,109	28 6	22 10	5 7	560,979
October	2,108,698	28 3	22 6	5 10	612,841
November	1,933,526	28 8	23 5	5 5	521,472
December	1,845,088	28 8	25 6	3 10	354,098
Year 1919	24,043,638	28 7	22 11	5 6	6,605,509

PRODUCTION OF GOLD IN RHODESIA AND WEST AFRICA.
Par Values.

	Rhodesia.		West Africa.	
	1919	1920	1918	* 1919
	£	oz.	£	£
January	211,917	43,428	107,863	104,063
February	220,885	—	112,865	112,616
March	225,808	—	112,605	112,543
April	213,160	—	117,520	109,570
May	218,057	—	126,290	100,827
June	214,215	—	120,273	106,612
July	214,919	—	117,581	102,467
August	207 339	—	120,526	103,112
September	223,719	—	115,152	100,401
October	204,184	—	61,461	91,352
November	186,462	—	108,796	98,322
December	158,835	—	112,621	98,806
Total	2,499,498	43,428	1,333,553	1,240,691

TRANSVAAL GOLD OUTPUTS.—Par Values.

	December, 1919		January, 1920	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Aurora West	14,000	14,371	14,200	17, 464
Barrett	—	—	—	202*
Brakpan	44,100	87,416	48,400	86,038
City & Suburban	18,318	28,386	13,722	24,971
City Deep	54,000	98,517	56,000	127,018
Cons. Langlaagte	35,100	48,781	43,500	63,977
Cons. Main Reef	41,000	70,324	46,800	86,424
Crown Mines	155,000	218,743	176,000	281,271
Durban Roodepoort Deep	19,800	27,300	23,000	36,445
East Rand P.M.	112,000	152,824	125,000	178,219
Ferreira Deep	31,000	42,618	34,100	57,337
Geduld	43,500	67,571	45,000	89,029
Geldenhuis Deep	44,000	52,998	48,000	69,570
Glynn's Lydenburg	2,930	4,689	3,300	7,733
Goch	13,500	11,949	15,400	14,385
Government G.M. Areas	103,000	194,591	111,000	240,848
Heriot	10,580	13,145	11,500	16,543
Jupiter	11,300	15,446	22,600	28,651
Kleinfontein	49,000	67,810	50,200	79,276
Knights Central	19,000	28,802	20,300	81,412
Knights Deep	80,900	59,358	88,800	81,412
Langlaagte Estate	33,670	38,879	35,650	50,916
Luipaard's Vlei	14,300	13,741	17,180	18,961
Meyer & Charlton	12,500	37,165	13,000	45,089
Modderfontein	75,600	173,992	81,000	225,098
Modderfontein B	51,000	104,077	56,000	141,069
Modderfontein Deep	41,100	98 083	44,000	125,103
New Unified	10,500	11,579	11,000	15,768
Nourse	37,700	50,912	42,000	7,044
Primrose	15,000	15,900	17,000	19,098
Princess Estate	16,700	19,782	18,500	26,461
Randfontein Central	133,500	153,326	145,000	217,191
Robinson	38,900	41,123	37,200	44,741
Robinson Deep	46,900	72,117	50,300	88,615
Roodepoort United	21,200	21,377	22,700	27,474
Rose Deep	45,000	50,805	52,000	66,273
Simmer & Jack	43,500	50,219	46,100	58,503
Simmer Deep	21,800	27,456	45,800	54,766
Springs	35,000	67,877	40,500	75,968
Sub Nigel	8,200	24,332	9,600	28,896
Transvaal G.M. Estates	15,710	25,719	16,480	32,873
Van Ryn	31,700	31,362	34,600	45,691
Van Ryn Deep	47,300	108,163	51,400	143,122
Village Deep	42,200	57,514	44,000	71,611
Village Main Reef	20,000	24,150	20,900	27,702
West Rand Consolidated	28,170	32,514	29,720	40,730
Witwatersrand (Knights)	29,550	35,459	31,200	45,473
Witwatersrand Deep	27,300	39 350	28,020	42,595
Wolhuter	25,000	35,099	29,800	45,284

* Fine Ounces.

WEST AFRICAN GOLD OUTPUTS.—Par Values.

	December, 1919		January, 1920	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Abbontiakoon	6,701	18,117	6,647	10,039
Abosso	7,320	12,571	7,354	16,876
Ashanti Goldfields	7,152	31,120	6,069	29,595
Offin River	—	—	—	—
Prestea Block A	13,312	22,332	11,872	20,067
Taquah	4,977	12,807	5,000	17,072

RHODESIAN GOLD OUTPUTS.—Par Values.

	December, 1919		January, 1920	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Falcon	7,434	3,757*	13,628	25,521*
Gaika	1,554	3,636	2,851	4,767
Globe & Phœnix	5,110	5,849†	5,239	10,929†
Lonely Reef	4,600	6,036†	4,550	5,916†
Rezende	4,900	8,720	5,000	10,148
Rhodesia, Ltd.	754	382	—	—
Rhodesia, G.M. & I.	570	324	585	2,002
Shamva	24,246	13,953	48,214	31,255
Transvaal & Rhodesian	1,800	4,294	1,750	4,417

*Gold, Silver and Copper; † Ounces Gold.

West Australian Gold Statistics.—Par Values.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
January, 1919	*	69,954	*	*
February	733	66,310	67,043	284,779
March	*nil*	65,158	66,158	281,120
April	33	63,465	63,498	269,720
May	525	68,655	69,180	293,856
June	1,050	73,546	74,596	316 862
July	680	68,028	68,708	292,852
August	835	58,117	58,952	250,410
September	†	†	†	†
October	586	64,987	65,573	278,535
November	1,171	64,823	65,994	280,323
December	831	27,334	28,165	162,575
January, 1920	836	25,670	26,506	112,590
February	1,928	49,453	51,381	218,251

* By direction of the Federal Government the export figures were not published. † Figures not received.

Australian Gold Returns.—Par Values.

	Victoria.		Queensland.		New South Wales	
	1918	1919	1918	1919	1919	1920
	£	£	£	£	£	£
January	32,134	36,238	47,600	37,100	18,000	28,000
February	58,113	46,955	45,470	43,330	24,000	—
March	65,412	40,267	48,020	48,000	16,000	—
April	29,620	63,818	47,600	61,200	24,000	—
May	87,885	37,456	46,740	38,200	16,000	—
June	45,765	41,465	51,420	44,600	17,000	—
July	64,347	37,395	51,000	42,060	22,000	—
August	61,163	51,564	44,600	49,700	20,000	—
September	65,751	76,340	45,900	37,120	13,000	—
October	*	39,018	54,400	36,100	28,000	—
November	*	40,735	38,200	32,720	51,000	—
December	70,674	63,311	56,281	44,500	31,000	—
Total	674,655	575,260	578,213	514,630	280,000	28,000

* Figures not received.

Australasian Gold Outputs.—Par Values.

	December, 1919		January, 1920	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Associated	—	—	3,968	6,379
Associated Northern Blocks:				
Iron Duke	—	—	—	854*
Victorious	—	597	—	352*
Blackwater	1,627	3,083	1,700	2,922
Bullfinch	5,100	4,846	5,200	5,958
Golden Horseshoe	—	—	7,428	16,500
Great Boulder Prop.	—	—	6,222	18,061
Ivanhoe	—	—	10,042	2,700
Kalgurli	—	—	2,705	6,327
Lake View & Star	—	—	—	—
Mount Boppy	2,815	3,680	—	—
Oroya Links	—	218†	1,035	6,144†
Progress	1,050	1,790	500	507
Sons of Gwalia	11,042	15,965	12,848	16,886
South Kalgurli	—	—	6,504	8,452
Talisman	—	—	—	—
Waihi	13,373	19,128‡	10,879	3,245‡
Waihi Grand Junction	4,400	6,606§	—	—

* Surplus; † Total receipts; ‡ Oz. Gold and Silver; § Gold and Silver.

Miscellaneous Gold Outputs.—Par Values.

	December, 1919		January, 1920	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Barramia (Sudan)	—	—	—	—
Esperanza (Mexico)	17,790	1,199§	18,541	1,075§
Frontino & Bolivia (C'lbia)	2,570	10,743	1,420	7,014
Nechi (Colombia)	84,678*	39,559†	166,475	42,823
Ouro Preto (Brazil)	7,200	14,000	7,400	17,049
Pato (Colombia)	219,789*	21,252†	119,367	46,016†
Philippine Dredges (P.I.)	—	—	—	—
Plymouth Cons. (Calif'rnia)	9,300	12,069	8,500	11,768
St. John del Rey (Brazil)	—	35,000	—	34,000
Santa Gertrudis (Mexico)	29,330	39,680‡	29,490	37,310‡
Sudan Gold Field (Sudan)	—	—	—	—

* Cubic yards. § Loss † Dollars. ‡ Profit, gold and silver.

Production of Gold in India.

	1916	1917	1918	1919	1920
	oz.	oz.	oz.	oz.	oz.
January	45,214	44,718	[illegible]	[illegible]	39,07[illegible]
February	43,121	42,566	[illegible]	[illegible]	—
March	43,702	44,617	41,719	38,317	—
April	44,797	43,726	41,504	38,248	—
May	45,055	42,901	40,899	38,698	—
June	[illegible]	[illegible]	41,264	38,359	—
July	[illegible]	[illegible]	[illegible]	[illegible]	—
August	[illegible]	42,591	40,496	37,850	—
September	45,255	43,207	40,088	36,813	—
October	45,061	43,041	[illegible]	[illegible]	—
November	45,247	42,915	[illegible]	[illegible]	—
December	48,276	44,883	[illegible]	[illegible]	—
Total	541,077	520,362	485,236	461,171	[illegible]

Indian Gold Outputs.

	December, 1919		January, 1920	
	Tons Treated	Fine Ounces	Tons Treated	Fine Ounces
Balaghat	3,250	2,328	3,300	2,114
Champion Reef	12,480	6,865	12,396	6,924
Hutti (Nizam's)	—	—	—	1,500
Mysore	20,113	16,300	19,652	12,882
North Anantapur	700	1,078	700	1,827
Nundydroog	8,662	6,886	8,490	6,283
Ooregum	12,900	9,186	12,900	7,541

Base Metal Outputs

		Dec. 1919	Jan. 1920
Arizona Copper	Short tons copper	1,450	1,500
British Broken Hill	Tons lead conc.	—	—
	Tons zinc conc.	—	—
	Tons carbonate ore	—	—
Broken Hill Block 10	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Burma Corp.	Tons refined lead	1,647	1,706
	Oz. refined silver	187,350	205,830
Cordoba Copper		—	
Fremantle Trading	Long tons lead	—	—
North Broken Hill	Tons lead	—	—
	Oz. silver	—	—
Poderosa	Tons copper ore	527	550
Rhodesian Broken Hill	Tons lead	1,202	1,271
Tanganyika	Long tons copper	2,156	2,058
Tolima	Tons silver-lead conc.	—	—
Zinc Corp.	Tons zinc conc.	—	—
	Tons lead conc.		

Imports of Ores, Metals, etc., into United Kingdom.

		Jan. 1920	Feb. 1920
Iron Ore	Tons	350,059	334,668
Manganese Ore	Tons	24,933	25,252
Copper and Iron Pyrites	Tons	28,852	29,236
Copper Ore, Matte, and Precipitate	Tons	1,317	4,806
Copper Metal	Tons	9,825	7,310
Tin Concentrate	Tons	4,285	1,506
Tin Metal	Tons	1,606	3,077
Lead, Pig and Sheet	Tons	5,888	[illegible]
Zinc (Spelter)	Tons	10,154	10,345
Quicksilver	Lb.	64,858	513,579
Zinc Oxide	Tons	3,117	597
White Lead	Cwt.	29 263	14,559
Barytes	Cwt.	37,132	23,658
Phosphate	Tons	48,850	20,743
Brimstone	Tons	790	337
Borax	Cwt.	—	40
Other Boron Compounds	Tons	3,204	1,977
Nitrate of Soda	Cwt.	163,542	193,440
Petroleum:			
Crude	Gallons	1,531,644	[illegible]
Lamp Oils	Gallons	11,817,994	[illegible]
Motor Spirit	Gallons	9,459,689	[illegible]
Lubricating Oils	Gallons	6,699,693	[illegible]
Gas Oil	Gallons	5 146,966	[illegible]
Fuel Oil	Gallons	22,787,549	[illegible]
Total Petroleum	Gallons	55,833,107	[illegible]

United States Metal Exports and Imports.

Exports.	Oct. Tons.	Nov. Tons.	Imports.	Oct. Tons.	Nov. Tons.
Copper Ingots	19,643	12,802	Antimony	1,083	251
Copper Tubes	350	197	Tin Con.	2,366	1,172
Copper Sheets	311	203	Tin	7,237	6,800
Copper Wire	1,835	1,464	Manganese Ore	15,863	11,694
Lead, Pig	3,721	2,511	TungstenCon	592	1,423
Zinc	9,650	5,009	Pyrites	67,155	40,259
Zinc Sheets	1,231	1,063			

Outputs of Tin Mining Companies.

In Tons of Concentrate.

	Dec. 1919 Tons	Year 1919 Tons	Jan. 1920 Tons
Nigeria:			
Abu	–	16	–
Anglo-Continental		117	–
Associated Nigerian	30	185	20
Benue	4	71	4
Berrida	–	1	–
Bisichi	11	199	14
Bongwelli	3	52	3
Dua	4	65	5
Ex-Lands	30	260	30
Filani	–	25	–
Forum River	13	169	11
Gold Coast Consolidated	2	33	2
Gurum River	15	118	17
Jantar	13	118	12
Jos	10	193	13
Kaduna	18	189	21
Kaduna Prospectors	7	72	8
Kano	8	142	10
Kassa-Ropp	–	84	–
Keffi	–	30	–
Kuru	17	266	17
Kuskie	1	13	–
Kwall	9	56	10
Lower Bisichi	7	78	7
Lucky Chance	1	27	1
Minna	2	38	8
Mongu	60	552	50
Naraguta	35	428	38
Naraguta Extended	20	276	17
New Lafon	–	125	–
Nigerian Tin	–	25	–
Ninghi	11	64	9
N.N. Bauchi	36	402	40
Offin River	–	50	19
Rayfield	45	618	40
Ropp	71	1,034	90
Rukuba	5	52	6
South Bukeru	10	64	12
Sybu	1	27	1
Tin Areas	–	67	–
Tin Fields	5	148	5
Toro	–	3	–
Union & Rhodesian Trust	–	6	–
Federated Malay States:			
Chenderiang	67	264	–
Gopeng	72	797	60
Idris Hydraulic	30	244	26
Ipoh	16	169	14
Kamunting	74	242	–
Kinta	30	438	36
Kledang	–	10	–
Lahat	46	463	30
Malayan Tin	44	605	53
Pahang	185	2,180	173
Rambutan	21	180	24
Sungei Besi	58	413	32
Tekka	39	458	39
Tekka-Taiping	25	314	33
Tronoh	69	1,409	100
Cornwall:			
Dolcoath	–	554	–
East Pool	81	991	70
Geevor	–	417½	27
Grenville	–	–	37
South Crofty	44	590	42
Other Countries:			
Aramayo Francke (Bolivia)	176	2,255	186
Briseis (Tasmania)	4	190	12
Deebook (Siam)	32	306	18
Mawchi (Burma)	82	760	123
Porco (Bolivia)	23	283	–
Renong (Siam)	56	829	63
Rooiberg Minerals (Transvaal)	6	241	28
Siamese Tin (Siam)	96	743	115
Tongkah Harbour (Siam)	89	1,244	76
Zaaiplaats (Transvaal)	15	278	20

Nigerian Tin Production.

In long tons of concentrate of unspecified content.
Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1915	1916	1917	1918	1919	1920
	Tons	Tons	Tons	Tons	Tons	Tons
January	417	531	667	678	613	543
February	358	528	646	668	623	—
March	418	547	655	707	606	—
April	444	486	555	584	546	—
May	357	536	509	525	483	—
June	373	510	473	492	484	—
July	455	506	479	545	481	—
August	438	498	551	571	616	—
September	442	535	538	520	561	—
October	511	584	578	491	625	—
November	467	679	621	472	536	—
December	533	654	655	518	511	—
Total	5,213	6,594	6,927	6,771	6,685	543

Production of Tin in Federated Malay States.

Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1916	1917	1918	1919	1920
	Tons	Tons	Tons	Tons	Tons
January	4,316	3,558	3,149	3,765	4,265
February	3,372	2,755	3,191	2,673	—
March	3,696	3,286	2,608	2,819	—
April	3,177	3,251	3,308	2,855	—
May	3,729	3,413	3,332	3,404	—
June	3,435	3,489	2,950	2,873	—
July	3,517	3,253	3,373	3,756	—
August	3,732	3,413	3,259	2,955	—
September	3,636	3,154	3,166	3,161	—
October	3,681	3,436	2,870	3,221	—
November	3,635	3,300	3,131	2,972	—
December	3,945	3,525	3,023	2,413	—
	43,871	39,833	37,370	36,867	4,265

Total Sales of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
July 14, 1919	145	£18,250	£125 17 3
July 28	122	£16,939	£138 16 11
August 11	127½	£17,125	£134 6 5
August 25	130½	£18,297	£140 4 3
September 8	115½	£16,588	£143 12 6
September 22	135½	£19,557	£144 6 9
October 8	72	£10,867	£150 18 7
October 20	32	£5,093	£159 3 2
November 3	34½	£5,235	£151 15 0
November 17	39	£6,161	£157 19 9
December 1	38	£5,905	£155 8 3
December 15	29	£5,133	£176 10 0
December 31	14¾	£2,884	£195 10 10
Total and Average, 1919	2,858	£366,569	£128 5 0
January 12, 1920	31	£6,243	£201 8 0
January 26	51¾	£10,574	£204 6 10
February 9	37½	£7,880	£210 2 8
February 23	53¾	£12,120	£225 10 0
March 8	18	£4,038	£224 7 7

Details of Redruth Tin Ticketings.

	February 9 Tons Sold	February 9 Realized per ton £ s. d.	February 23 Tons Sold	February 23 Realized per ton £ s. d.
Tincroft Mines	5	233 15 0	5	244 0 0
" "	6	234 0 0	6	242 15 0
Trencrom	–	—	1¼	216 0 0
Penryn Minerals	10½	192 7 6	5	209 0 0
" "	6½	200 5 0	5	210 15 0
" "	7¼	209 15 0	5	214 0 0
" "	–	—	5½	210 0 0
" "	–	—	5	210 5 0
Levant	–	—	15	236 0 0
Pendeen	2¼	207 17 6	–	—
Progo	–	—	1	259 0 0
Total	37½		53¾	

Stocks of Tin

Reported by A. Strauss & Co. Long Tons.

	Jan. 31, 1920	Feb. 29, 1920
	Tons	Tons
Straits and Australian Spot	227	1,023
Ditto, Landing and in Transit	1,370	1,783
Other Standard, Spot and Landing	1,657	1,303
Straits, Afloat	2,635	2,335
Australian, Afloat	248	248
Banca, in Holland	2,610	2,939
Ditto, Afloat	854	1,845
Billiton, Spot	—	—
Billiton, Afloat	132	112
Straits, Spot in Holland and Hamburg	—	
Ditto, Afloat to Continent	150	390
Total Afloat for United States	7,374	5,751
Stock in America	3,723	3,743
Total	20,980	21,472

Shipments, Imports, Supply, and Consumption of Tin.

Reported by A. Strauss & Co. Long tons.

	Jan. 1920	Feb. 1920
Shipments from :	Tons	Tons
Straits to U.K.	1,340	2,030
Straits to America	2,420	2,390
Straits to Continent	150	390
Straits to Other Places	330	118
Australia to U.K.	250	250
U.K. to America	650	725
Imports of Bolivian Tin into Europe	1,726	2309
Supply :		
Straits	3,910	4,810
Australian	250	250
Billiton	—	112
Banca	1,200*	2,036
Standard	454	920
Total	5,814	8,128
Consumption :		
U K. Deliveries	1,465	1,714
Dutch „	762	562
American „	3,910	5,200
Straits, Banca & Billiton, Continental Ports, etc.	187	160
Total	6,325	7,636

* Estimated.

Dividends Declared by Mining Companies

Date	Company	Par Value of Shares	Amount of Dividend
January 12	Aramayo Francke	£1	1s. less tax
February 11	Associated Northern Blocks	£1.	[illegible] free of tax
January 17	Berenguela Tin	[illegible]	1s. 6d.
February 26	Broken Hill Block 10	£10. (£9. 13s. paid)	1s. less tax
February 26	Broken Hill Block 14	Pref. 6s.	9·6d. less tax
		Ord 25s.	6d. less tax
January 24	Broken Hill Prop.	£1	9d.
February 28	Chino Copper	$5.	[illegible] cents
March 9	Cons. Mines Selecti'n	10s.	3s 6d.
January 19	Eastern Smelting	Ord. £1.	3s.
February 11	Exploration	10s.	[illegible] free of tax
January 15	Idris Hydraulic Tin	£1	1s. less tax
January 12	Ipoh Tin Dredging	£1	2s. less tax
March 4	Kassa Ropp Tin	10s.	1s. less tax
February 18	Kinta	£1	[illegible]s. free of tax
March 5	Kramat Pulai	£1	[illegible]s. less tax
February 19	Le Roi No. [illegible]	£5	[illegible]s. less tax
January 7	Lonely Reef	£1.	[illegible]s. less tax
March 4	Malayan Tin	£1	1s. less tax
March 5	Mexico of El Oro	£1	4s. free of tax
March 5	Mining Corporation of Canada	$5	12½ cents less tax
February 26	Mysore	10s.	1s. less tax
February 28	Nevada Cons. Copper	$5.	25 cents.
January 6	Nigerian Tin Corp.	£1.	2s.
February 19	North Anantapur	Pref. £1.	4s. less tax
February 18	Nundydroog	10s.	1s. less tax
January 10	Oriental Consolidated	$10.	50 cents.
March 4	Oroville Dredging	£1	9d. less tax
February 18	Ouro Preto	Pref. £1.	2s.
February 28	Ray Cons. Copper	$10.	25 cents.
March 4	South African Gold Trust	£1	1s. 6d. free of tax
January 1	South African Townships, Mining and Finance	£1.	2s.
January 15	Sungei Besi	£1.	1s. less tax
January 21	Tekka	£1.	1s. 6d. + bonus 2s. 6d. less tax
February 16	Tekka-Taiping	£1.	3d. less tax
February 28	Utah Copper	$10.	$1·50
February 12	Vereeniging Estates.	£1.	1s. less tax
January 27	Waihi	£1.	1s. free of tax
February 17	Wankie Colliery	10s.	1s. less tax
February 25	Witbank Colliery	£1	2s. 6d.

The dividends declared in December and January by Transvaal gold-mining companies were tabulated under Review of Mining in the February number of *The Mining Magazine*

PRICES OF CHEMICALS. March 9.

		£	s.	d.
Alum	per ton	16	10	0
Alumina, Sulphate of	„	16	10	0
Ammonia, Anhydrous	per lb.		2	0
„ 0·880 solution	per ton	37	10	0
„ Carbonate	per lb.			7½
„ Chloride of, grey	per ton	50	0	0
„ „ „ pure	per cwt.	4	15	0
„ Nitrate of	per ton	63	10	0
„ Phosphate of	„	110	0	0
„ Sulphate of	„	22	0	0
Antimony Sulphide, Golden	per lb.		1	3
Arsenic, White	per ton	74	0	0
Barium Sulphate	„	12	0	0
Bisulphate of Carbon	„	56	0	0
Bleaching Powder, 35% Cl.	„	17	0	0
Borax	„	41	0	0
Copper, Sulphate of	„	48	0	0
Cyanide of Sodium, 100%	per lb.			11
Hydrofluoric Acid	„			7½
Iodine	„		16	0
Iron, Sulphate of	per ton	4	0	0
Lead, Acetate of, white	„	95	0	0
„ Nitrate of	„	70	0	0
„ Oxide of, Litharge	„	71	0	0
„ White	„	73	0	0
Lime, Acetate, brown	„	18	0	0
„ „ grey 80%	„	30	0	0
Magnesite, Calcined	„	22	0	0
Magnesium, Chloride	„	16	0	0
„ Sulphate	„	12	0	0
Methylated Spirit 64° Industrial	per gal.		5	7
Phosphoric Acid	per lb.		1	9
Potassium Bichromate	per lb.		1	4
„ Carbonate 85%	per ton	100	0	[illegible]
„ Chlorate	per lb.		1	0
„ Chloride 80%	per ton	25	0	0
„ Hydrate (Caustic) 90%	„	120	0	0
„ Nitrate	„	75	0	0
„ Permanganate	per lb.		3	6
„ Prussiate, Yellow	„		2	[illegible]
„ Sulphate, 90%	per ton	25	0	0
Sodium Metal	per lb.		1	[illegible]
„ Acetate	per ton	60	0	0
„ Arsenate 45%	„	60	0	0
„ Bicarbonate	„	8	10	0
„ Bichromate	per lb.			9
„ Carbonate (Soda Ash)	per ton	16	0	0
„ „ (Crystals)	„	5	10	0
„ Chlorate	per lb.			6
„ Hydrate, 76%	per ton	24	0	0
„ Hyposulphite	„	24	10	0
„ Nitrate, 95%	„	26	0	0
„ Phosphate	„	40	0	0
„ Prussiate	per lb.		1	10
„ Silicate	per ton	12	0	0
„ Sulphate (Salt-cake)	„	4	10	0
„ „ (Glauber's Salts)	„	4	5	[illegible]
„ Sulphide	„	41	0	0
Sulphur, Roll	„	22	0	0
„ Flowers	„	22	0	0
Sulphuric Acid, Non-Arsenical, 140° T.	„	5	0	[illegible]
„ „ „ 90%	„	7	[illegible]	
„ „ „ 96%	„	9	7	6
Superphosphate of Lime, 18%	„	[illegible]	0	0
Tartaric Acid	per lb.		3	6
Zinc Chloride	per ton	27	0	0
Zinc Sulphate	„	22	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	March 7 1919 £ s. d.	March 5 1920 £ s. d.
RAND:		
Brakpan	3 16 3	3 15 0
Central Mining (£8)	8 5 9	11 3 9
City & Suburban (£4)	12 0	8 0
City Deep	2 13 0	3 5 0
Consolidated Gold Fields	1 15 0	2 2 6
Consolidated Langlaagte	18 0	1 8 0
Consolidated Main Reef	15 6	15 6
Consolidated Mines Selection (10s.)	1 8 6	1 13 3
Crown Mines (10s.)	2 6 3	4 0 0
Daggafontein	1 10 6	1 0 6
Durban Roodepoort Deep	8 9	11 3
East Rand Proprietary	5 0	14 6
Ferreira Deep	13 0	13 0
Geduld	2 12 0	2 15 0
Geldenhuis Deep	13 0	15 0
Gov't Gold Mining Areas	4 15 6	4 17 6
Heriot	18 9	12 0
Johannesburg Consolidated	26 6	1 15 0
Jupiter	4 6	7 0
Kleinfontein	14 0	16 3
Knight Central	5 6	6 9
Knights Deep	8 6	12 6
Langlaagte Estate	19 0	1 0 0
Meyer & Charlton	4 10 0	4 17 6
Modderfontein (10s.)	27 5 0*	4 3 9
Modderfontein B	8 0 0	7 17 6
Modder Deep (5s.)	7 10 0†	2 13 9
Modder East	—	1 8 9
New State Areas	—	1 10 0
Nourse	16 3	16 9
Rand Mines (5s.)	3 0 6	4 6 3
Rand Selection Corporation	4 1 3	5 2 6
Randfontein Central	14 3	1 2 0
Robinson (£5)	15 0	13 0
Robinson Deep A (1s.)	18 9	1 10 0
Rose Deep	17 6	1 3 9
Simmer & Jack	5 0	6 9
Simmer Deep	3 0	3 3
Springs	3 11 3	2 18 9
Sub-Nigel	1 10 0	1 0 0
Union Corporation (12s. 6d.)	16 6	1 3 6
Van Ryn	17 0	1 2 6
Van Ryn Deep	3 11 3	5 0 0
Village Deep	17 6	17 3
Village Main Reef	14 6	9 0
West Springs	—	1 5 0
Witwatersrand (Knight's)	1 1 3	1 4 3
Witwatersrand Deep	11 0	14 0
Wolhuter	5 0	6 9
OTHER TRANSVAAL GOLD MINES:		
Glynn's Lydenburg	1 3 9	17 6
Transvaal Gold Mining Estates	14 0	16 9
DIAMONDS IN SOUTH AFRICA:		
De Beers Deferred (£2 10s.)	19 2 6	30 0 0
Jagersfontein	4 17 6	6 15 0
Premier Deferred (2s. 6d.)	7 7 6	12 5 0
RHODESIA:		
Cam & Motor	8 0	13 0
Chartered British South Africa	1 1 6	1 1 0
Falcon	13 3	14 9
Gaika	15 6	15 6
Giant	7 3	8 6
Globe & Phœnix (5s.)	1 9 6	14 0
Lonely Reef	1 19 0	3 6 3
Rezende	4 18 9	3 15 0
Shamva	1 17 6	2 3 9
Willoughby's (10s.)	6 6	6 9
WEST AFRICA:		
Abbontiakoon (10s.)	4 9	5 0
Abosso	6 6	14 0
Ashanti (4s.)	1 1 6	1 2 9
Prestea Block A	5 0	4 9
Taquah	14 6	1 0 0
WEST AUSTRALIA:		
Associated Gold Mines	4 6	5 6
Associated Northern Blocks	4 3	5 6
Bullfinch	1 9	9 0
Golden Horse Shoe (£5)	1 15 6	1 6 3
Great Boulder Proprietary (2s.)	12 3	8 9
Great Fingall (10s).	2 0	2 6
Hampton Properties	—	1 18 9
Ivanhoe (£5)	1 17 6	2 7 6
Kalgurli	12 6	18 9
Lake View Investment (10s.)	15 3	19 0
Sons of Gwalia	8 6	10 0
South Kalgurli (10s.)	7 0	6 3

GOLD, SILVER, *cont.*	March 7 1919 £ s. d.	March 5 1920 £ s. d.
OTHERS IN AUSTRALASIA:		
Blackwater, New Zealand	8 9	8 9
Consolidated G.F. of New Zealand	3 9	3 9
Mount Boppy, New South Wales	3 9	5 6
Progress, New Zealand	1 9	1 9
Talisman, New Zealand	12 6	8 9
Waihi, New Zealand	2 2 6	2 6 3
Waihi Grand Junction, New Z'lnd	15 0	11 3
AMERICA:		
Buena Tierra, Mexico	1 1 3	12 6
Camp Bird, Colorado	17 6	1 1 6
El Oro, Mexico	16 6	15 3
Esperanza, Mexico	17 3	17 0
Frontino & Bolivia, Colombia	11 3	11 9
Le Roi No. 2 (£5), British Columbia	8 9	10 0
Mexico Mines of El Oro, Mexico	6 12 6	8 5 0
Nechi (Pref. 10s.), Colombia	11 6	10 6
Oroville Dredging, Colombia	1 0 0	1 7 6
Plymouth Consolidated, California	1 2 6	1 1 3
St. John del Rey, Brazil	17 6	18 0
Santa Gertrudis, Mexico	17 9	1 15 3
Tomboy, Colorado	15 0	13 9
RUSSIA:		
Lena Goldfields	1 15 0	1 8 9
Orsk Priority	12 6	12 6
INDIA:		
Balaghat	4 6	9 9
Champion Reef (2s. 6d.)	4 3	4 3
Mysore (10s.)	2 3 9	1 0 0
North Anantapur	3 0	4 6
Nundydroog (10s.)	1 2 0	17 3
Ooregum (10s.)	16 6	18 0
COPPER:		
Arizona Copper (5s.), Arizona	1 17 6	3 6 3
Cape Copper (£2), Cape and India	2 12 6	2 0 0
Esperanza, Spain	7 6	5 9
Hampden Cloncurry, Queensland	1 0 6	18 0
Mason & Barry, Portugal	2 13 9	2 10 0
Messina (5s.), Transvaal	5 0	6 6
Mount Elliott (£5), Queensland	3 10 0	3 10 0
Mount Lyell, Tasmania	1 4 0	1 6 6
Mount Morgan, Queensland	1 4 6	1 6 6
Mount Oxide, Queensland	6 3	8 0
Namaqua (£2), Cape Province	2 0 0	1 12 6
Rio Tinto (£5), Spain	61 0 0	46 10 0
Russo-Asiatic Consd., Russia	—	14 3
Sissert, Russia	1 1 3	16 3
Spassky, Russia	1 10 0	1 7 6
Tanganyika, Congo and Rhodesia	4 13 9	2 16 3
LEAD-ZINC:		
BROKEN HILL:		
Amalgamated Zinc	1 12 0	1 6 6
British Broken Hill	2 3 9	2 5 0
Broken Hill Proprietary (8s.)	2 10 0	3 2 6
Broken Hill Block 10 (£10)	1 10 6	1 7 6
Broken Hill North	2 18 9	2 7 6
Broken Hill South	2 18 9	2 18 9
Sulphide Corporation (15s.)	1 4 0	1 0 6
Zinc Corporation (10s.)	1 5 9	1 1 6
ASIA:		
Burma Corporation	5 5 0	12 17 6
Russian Mining	17 6	15 0
RHODESIA:		
Rhodesia Broken Hill (5s.)	13 6	17 0
TIN:		
Aramayo Francke, Bolivia	3 2 6	5 5 0
Bisichi, Nigeria	14 0	16 0
Briseis, Tasmania	5 0	5 3
Dolcoath, Cornwall	8 0	8 6
East Pool (5s.) Cornwall	1 5 9	18 0
Ex-Lands Nigeria (2s.), Nigeria	2 9	4 6
Geevor (10s.) Cornwall	15 6	1 2 6
Gopeng, Malay	2 0 0	2 8 9
Ipoh Dredging, Malay	1 1 6	1 9 0
Kamunting, Malaya	1 18 9	2 10 0
Kinta, Malaya	2 7 6	3 1 3
Malayan Tin Dredging, Malay	2 5 0	2 13 9
Mongu (10s.), Nigeria	16 0	1 8 6
Naraguta, Nigeria	18 0	18 9
N. N. Bauchi, Nigeria (10s.)	8 0	9 0
Pahang Consolidated (5s.), Malay.	15 0	15 3
Rayfield, Nigeria	14 0	14 6
Renong Dredging, Siam	2 0 0	2 13 9
Ropp (4s.), Nigeria	1 1 9	16 9
Siamese Tin, Siam	3 3 9	4 10 0
South Crofty (5s.), Cornwall	2 0 0	17 9
Tehidy Minerals (15s. pd.) Cornw'l	—	1 7 6
Tekka, Malay	3 10 0	5 5 0
Tekka-Taiping, Malay	3 17 6	1 11 3
Tronoh, Malay	1 17 6	2 15 0

* £4 shares split into 8 of 10s. each. † £1 shares split into 4 of 5s. each.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

THE S & M TIN-WOLFRAM-BISMUTH MINE, TASMANIA.

The *Proceedings* of the Australasian Institute of Mining and Metallurgy, No. 35, 1919, contains a paper by W. E. Hitchcock and J. R. Pound describing the S & M tin-wolfram-bismuth mine and the method of concentrating the ore. This mine belongs to an English company, the S & M Syndicate, Ltd., and is in the Moina mining district on the hills between the Forth and Iris rivers, about 36 miles south of Devonport, a port on the north coast of the island.

The tin-wolfram lodes at Moina are a complex of veins traversing beds of sandstone or quartzite and lime-silicate rock. These rocks form a contact metamorphic aureole surrounding a mass of granite and granite-porphyry which is exposed farther east and south for a width of between two and three miles, and for about a mile from north to south. This exposure of granite represents one of the many uprisings of acid magma which occurred in different parts of Tasmania during the Devonian period. The age of the sedimentary beds intersected by the lodes has a range which is taken to extend through the Lower and Middle Silurian. The occurrence of the lime-silicate rock at the S and M mine points to the alteration of original limestone within the zone of contact metamorphism. The rock consists of magnetite, fluor-spar, garnet, and vesuvianite, with epidote and veins of pink felspar. The contact metamorphic minerals are, on the other hand, absent from the mineral lodes in this rock. The lode gangue consists mainly of quartz, topaz, fluor-spar, and mica. Its structure is pegmatitic, and the tin, wolfram, bismuth, and molybdenum minerals are usually reckoned as pneumatolytic in nature and origin.

Though most of the lodes are in sandstone or quartzite, others are in granite. The ores may be considered as having had their source in the granite magma.

At the S & M mine five lodes are worked. A striking feature is the persistency of the lodes in length and the fairly uniform widths. Bulges or pinches do not occur, but the lodes frequently split into veins, the aggregate widths of which are usually that of the lodes where solid. Nearing the lateral limits the lodes become reduced in size, and usually split up into small veins. The gangue consists of quartz accompanied by fluor-spar, mica, and topaz, and the minerals are cassiterite, wolfram, scheelite, bismuthinite, bismutite, and pyrite. Chalcopyrite and molybdenite also occur sparingly, and galena has been noted. The values do not occur in shoots, but are irregularly distributed, and it is consequently necessary to take out the whole length of the lodes to avoid missing the richer patches, of which there is usually no indication until they are met. The lodes have no walls, and it is necessary to break the country-rock on each side to the working width of drive or stope. At present the greatest depth of the workings from the surface is 300 ft., and the lodes at this depth, as compared with those at the surface, do not show any very serious lowering in values in cassiterite and wolfram. The bismuth values, however, do show a reduction, as the richer patches were met with near the surface.

The lodes consist mainly of quartz of a fairly friable nature, enclosed in rocks which are hard. The minerals are easily freed from the gangue, and probably 60 to 70% is already freed before reaching the mill. The wolframite and bismuthinite occur in lumps and patches, and the cassiterite in coarse grains up to ½ in. or more in diameter. After the ore has passed through the rock-breaker very little remains to be freed, and after reduction by rolls to a maximum of ½ in. diameter, practically the whole of the balance is liberated. Thus comminution does not enter very largely into the process. The country-rock, especially the quartzite, contains fine grains of pyrite disseminated through it, and the garnet rock contains much magnetite. The object, therefore, is to liberate the valuable minerals and as little as possible of the impurities. The concentrates from all machines in the mill are produced in two grades, firsts and seconds. The idea with regard to the firsts is to retain all the valuable minerals, but to reject the pyrite and silica, and with the seconds to retain the pyrite and reject the silica as far as practicable. It is thus possible to aim at a clean firsts product which is practically free from pyrite and magnetite.

The percentages of contents of firsts and of seconds are approximately as follows:

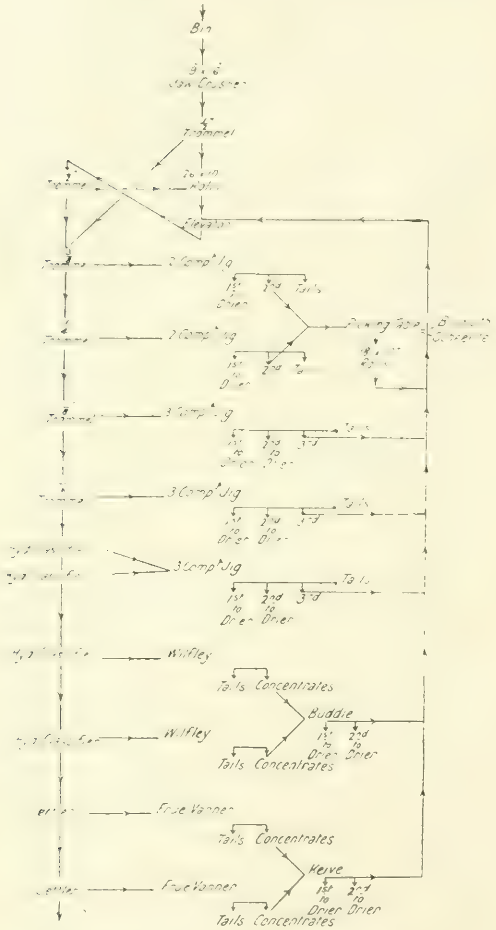
Firsts: Sn 35, WO_3 35, Bi 2·5. Seconds: Sn 12, WO_3 10, Bi 3·5.

In 1906 it was decided to remodel the mill. Rolls, trommels, additional jigs, and Wilfleys were installed, and the old stamps were hung up. The flow-sheet on the next page gives an outline of present methods of concentration.

From the breaker the ore, assisted by water jets, passes to a conical trommel with ½ in. round holes. The under-size passes to a series of trommels and the over-size to rolls. From the rolls the ore goes to a trommel with ½ in. holes. The over-size from this trommel returns to the rolls and the under-size to the next trommel. This has screens with ¼ in. and ⅜ in. holes. The under-size of the ¼ in. goes to the next following trommel, and the under-size and over-size of the ⅜ in. trommel feed respective jigs. These jigs yield products from sieves through gate discharges and from hutches. From the gates from the first compartment the products consist of firsts concentrates; these are hand-picked for bismuth ore and for scheelite, and are then bagged as firsts. From the gates from the second compartment the concentrates, after hand-picking for bismuth ore and scheelite, are passed through a pair of rolls and then returned to the mill circuit. From the hutches of the first compartment is obtained a product which, after hand-sieving, is good enough for firsts; and from the hutches of the second compartment is obtained a product that either is made good enough for seconds by the same process or is returned to the mill circuit.

The sizes from the ⅛ in. and $\frac{1}{16}$ in. trommels are fed to jigs, and the under-size from the $\frac{1}{16}$ in. passes to a pair of hydraulic classifiers. It is found preferable to divide the feed to two classifiers in place of one large one. Spigot discharges from these classifiers provide feed for a fine jig. These jigs have three compartments:

firsts are obtained as a product from the first hutch, seconds from the second hutch, and the product from the third hutch is fed again to the mill circuit. The third hutch is a stand-by in cases where the adjustment of the jig or bedding is interfered with by a rush of feed or mineral. The first and second hutch products (except from the fine jig, which yields a clean product) are hand-sieved to remove a little fine sand, and are then clean enough to dry and bag. By careful adjust-



Flow-Sheet of S and M Concentrator.

ment of the jigs, the scheelite is passed as much as possible into the seconds; the seconds contain, as a rule, more bismuth than the firsts. It is necessary to attend carefully to the adjustment of the jigs in stroke, bedding, and water supply. The bedding or ragging particularly requires attention on account of the varying contents of the ore. The overflow from the hydraulic classifiers passes to two Rittinger classifiers, from which the spigots feed Wilfley tables, and the overflow goes to a two-compartment settler. The concentrates from the Wilfley tables are dressed up in a buddle by hand into firsts, seconds, and tails, the latter being returned to the mill circuit. Although a fairly good concentrate is obtained from the tables, it is not considered advisable, on account of the varying metal contents of the feed, to attempt to make a clean product. The tails from the Wilfley tables were for a while passed over a fine jig, but the results did not justify this, and they are now allowed to run away.

The settler provides feed for two Frue vanners, the concentrates from which are dressed up in a tossing tub, or keive, to firsts, seconds, and tails, the latter being returned to the mill circuit. The tails from the vanners and the fine Wilfley were passed over canvas tables, but the concentrate obtained barely paid for the renewal of the canvas; and in this case the canvas tables or strakes were not a success. This was mainly owing to the large amount of magnetite contained in the pulp, and to the fact that they did not present any better methods of saving than the machines the tailing from which they treated. The product from the canvas tables was a very foul one, although the tables were well looked after; and considerable dressing by hand was required to bring it up to anything like a decent standard. In such cases, if the losses, not being due to faulty working of the vanners, justify it, the remedy appears to be to install further machines of different adjustment.

All the concentrates produced are drained and dried. A small furnace at one end, so arranged that the flame does not come in contact with the plates, provides the heating. After drying, the concentrates are bagged in 1 cwt. bags and despatched to a magnetic separation works at Launceston, owned by the syndicate.

Since milling was started by the present owners in 1907, the quantity milled to December 31, 1918, was 72,884 tons. The production of concentrates from this has been as follows:

	Tons.
Firsts, containing Sn, WO_3, and Bi	822·00
Seconds, containing Sn, WO_3, Bi, and Pyrite	354·55
Slimes, containing Sn, WO_3, and Bi	66·95
Bismuth Ore, hand-picked	26·80
Wolfram, hand-picked	3·25
Tin Ore	0·05
Total Concentrates	1273·60

The authors then proceed to give details of the separation of the ores at the works of the S and M Syndicate, at Launceston. Wetherill magnetic separators are used, with accessory appliances for crushing and sieving the ore to be treated. The concentrates are crushed, as necessary, in rolls, and sieved when dry through a set of shaking screens until the whole is divided into four sizes, ranging from $\frac{1}{8}$ in. in diameter downward. Each size is then treated on a magnetic separator.

As already mentioned the firsts contain mainly bismuthinite, cassiterite, and wolfram, which are the minerals of economic importance, and together make up about 98% by weight of the concentrate. The remaining 2% by weight consists of pyrite, magnetite, scheelite, and silica. The seconds contain all the minerals in quantity, together with small amounts of chalcopyrite, molybdenite, siderite, and other minerals. The firsts, on treatment with the magnetic separators, give a little magnetite product from the first two V poles, those of the weak electro-magnet, then a wolfram product from the last two V poles, those of the strong electro-magnet, and finally a non-magnetic product of cassiterite and bismuthinite, with small amounts of scheelite, silica, and pyrite. The magnetite product contains a little magnetic pyrites and merely traces of the valuable metals. The wolfram product averages about 73% WO_3, with 0·7% Sn and the merest trace of Bi, while the tin-bismuth product assays in general about 63% Sn and 4% Bi, with 2% WO_3 or more, depending on the amount of scheelite present. The wolfram product was at the time of writing sold to the

British Government, and the tin-bismuth ore is sold to an English chemical works, where the bismuth is extracted, and then the remaining tin ore is sent to a tin-smelter.

The magnetic separation process gives the following results from the firsts :

Product	% Wt.	Assays			Recoveries		
		$\%WO_3$	%Sn.	% Bi.	WO_3	%Sn	%Bi.
Iron minerals	0·5	—	—	—			
Wolfram	42·5	73	0·7	-	[illegible]	[illegible]	–
Tin-Bismuth	57·0	2	63·0	4	3·1	[illegible]	100
Original firsts	100·0	36·5	36·2	2·3	[illegible]	100·0	100

Scheelite is an undesirable mineral in these concentrates, as it is non-magnetic, and therefore cannot be separated from the tin-bismuth ore by magnetic separators. The wolfram content of the final tin-bismuth product does not exceed 1% of its weight, and of this a considerable part is associated with the cassiterite. A single particle, consisting of wolfram and cassiterite together, will pass into the wolfram or tin-bismuth product, according as the one or the other mineral is in excess ; in either case the quality of the separation suffers.

The seconds, on treatment by the magnetic separators, give three products. The first product consists of magnetite and magnetic pyrites, the former predominating. The major portion of the product comes off from the first V pole, and is almost wholly magnetite, while from the second V pole comes the minor portion, which contains the bulk of the magnetic pyrites. The magnetite occurring in the concentrates contains some rock minerals intimately associated with it, but it is still quite strongly magnetic. This iron-product contains very small amounts of the valuable metals, and is removed as waste. The second product from the machining of the seconds contains wolfram with considerable magnetic pyrite and smaller amounts of siderite and garnet or vesuvianite. The third, or non-magnetic product, contains bismuthinite, cassiterite, pyrite, scheelite, silica, etc., that is, all the non-magnetic minerals present in the original seconds. This product may contain over 50% by weight of pyrite.

The pyrite in the seconds thus varies in magnetic quality, though the bulk of it is non-magnetic. Pure, hand-picked specimens of the pyrite from the above three products were assayed, with the following results :

	1. Strongly Magnetic	2 Weakly Magnetic	3 Non-Magnetic
% Fe	45·1	45·3	45·5
% S	47·4	47·3	[illegible]
% Cu	0·0	0·0	2·1
% insoluble	3·8	3·0	0·7
% soluble (by difference)	3·7	4·4	1·4
Ratio, S : Fe.	1·052	1·045	1·105

Sample 3 contained appreciable copper, the figure for which includes a little bismuth. The sulphur contents are most likely to have been under-estimated. The notable feature is that the magnetic varieties of the pyrite contain the most impurities.

The pyritic wolfram and the pyritic tin-bismuth products from the machining of the seconds are both of too low a grade to send direct to market. Advantage is now taken of the fact that iron pyrites (FeS_2) may be converted into strongly magnetic sulphide and oxide of iron—approximately Fe_3S_4 and Fe_3O_4—by means of a partial roast. The two products are therefore separately roasted, cooled, and then again treated on the Wetherill machines, when the strongly magnetic roasted pyrite is removed by the first weak electro-magnet, leaving the wolfram or the tin-bismuth ore to be recovered later from the machine as a high-grade product.

In roasting pyrite for magnetism the aim is to get a product of uniform magnetic quality, which will consist of magnetic sulphide and oxide of iron. The larger particles, after roasting, will contain a kernel of unaltered pyrite, then a layer of magnetic sulphide, and on the outside a coating of magnetic oxide. The finer particles of roasted ore will be practically wholly magnetic oxide. Coarse ore takes a longer time to roast to a required magnetic quality than fine ore, and the ore should therefore be carefully sized before roasting. It should all pass through a 10 mesh sieve. Material of half this size, and less, behaves better as regards the roasting, but then the extra crushing and the behaviour on the magnetic separators would become serious items. It is the Launceston practice to crush the seconds into three sizes, from 0·05 in. diameter downward, each size being subsequently treated by itself.

At the works in Launceston the closely-sized products are roasted in a small muffle furnace, and are rabbled by hand. Air is admitted in limited quantity through the door of the muffle, and the gaseous products of the roasting—sulphur and sulphur dioxide—pass out at the farther end of the muffle and into the chimney. The cast-iron muffle is heated by a wood fire placed at one side, and the flame passes right round it and then up the chimney, the draught of which also causes the air-current through the muffle. The ore charge is about 2 in. deep, and is rabbled from 4 to 6 times an hour. The average time of roasting a charge, approximately $1\frac{1}{8}$ cwt., is $1\frac{1}{2}$ hours. The furnace treats $5\frac{1}{4}$ tons of ore per week of six days, with a fuel consumption of $8\frac{3}{4}$ tons of firewood. This type of furnace is only suitable for small tonnages, such as are dealt with, and is thus expensive compared with larger installations with mechanical feeding and rabbling. A good muffle ought to last out the roasting of 100 tons of pyritic ore. The great advantage of this type of furnace is that the dust losses are reduced to a minimum. The results obtained are satisfactory, as the end-point of a roast can be judged with accuracy, and small variations in the temperature, rabbling, time of roasting, and quantity and quality of the ore roasted can thus be arranged so as to compensate each other. When finishing off the roasting of a charge of ore the muffle is at a good red heat, say at 650°C. If the temperature is lower the roasting takes too long ; if higher the various ore-particles frit together excessively, and the subsequent magnetic separation is adversely affected.

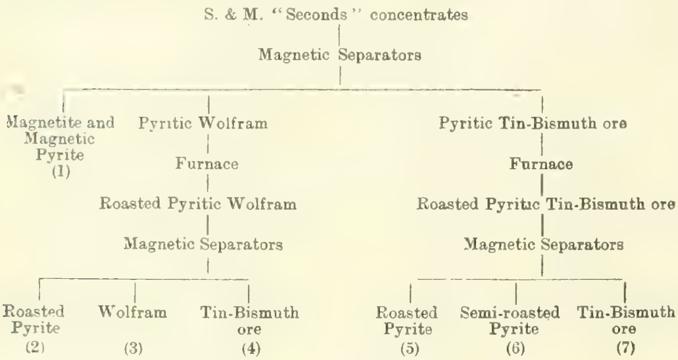
When the roasting is approaching completion, the charge of ore should throw off very few sparks on rabbling. During the early stages of the roast this sparking of the charge is pronounced ; it is due to the decrepitation of the pyrite and the incandescence of the rapidly burning particles that are thrown up from the surface of the charge. Also, at the end of the roast the ore will appear uniformly red hot, and will give a short flame on rabbling, not a long flame as when half done. The cooled roasted ore should be dull grey-black in colour, and no shiny particles of unaltered pyrite should be visible. Only the surface of the cooled roasted charge should show a reddish-brown tint, due to further oxidation to ferric oxide ; if there is a red-brown tint throughout, the charge is over-roasted. Ferric oxide is feebly paramagnetic, and the aim is to form the strongly paramagnetic compounds of iron.

TABLE OF THE RESULTS OBTAINED FROM THE S AND M SECONDS.

Products	% Wt.	Assays % Bi.	Sn.	WO₃.	Cu.	Si O₂.	Sol.	Distribution % Bi.	Sn.	WO₃.	Cu.	Si O₂.	Sol
(1) Magnetite and Magnetic Pyrite ...	15·0	0·5	1·5	0·6	0	9·5	87·1	2	2	1	0	18	23
(2) Roasted Pyrite ...	3·1	4·9	2·8	10·6	0·5								
(3) Wolfram ...	11·2	1·0	3·2	59·2	0	8·6	6·8	3	3	70	0	12	1
(4) Tin-Bismuth ore ...	0·1	1·7	51·5	6·3	0								
(5) Roasted Pyrite ...	35·2	6·4	3·5	0·9	1·2								
(6) Semi-roasted Pyrite ...	6·5	6·1	22·0	14·3	2·0	13·9	28·6	12	12	9	20	11	3
(7) Tin-Bismuth ore ...	17·5	2·3	47·4	7·1	0·5								
Slimes ...	1·2	3	12	9	0·7	8	59	1	1	1	1	1	1
Loss ...	10·2	0	0	0	0	0	100	0	0	0	0	0	17
Total ...	100	3·4	11·8	9·7	0·66	8·2	58·7	100	100	100	100	100	100
(2) + (5) = Total Roasted Pyrite ...	38·3	6·3	3·4	1·7	1·1	3·0	81·1	70	11	7	65	14	53
(4) + (7) = Total Tin-Bismuth Ore ...	17·6	2·3	47·4	7·1	0·5	20·6	7·0	12	71	12	14	44	2

Under the heading "SiO_2" is included all matter insoluble in acids (aqua regia), excepting the SnO_2 and WO_3. Under the heading "Sol." is included all matter soluble in acids, excepting the Bi_2S_3, the (Fe Mn) O and Ca O from the wolfram and scheelite, and the Cu S corresponding to the Cu.

The composition of the slimes has been assumed to be the same as that of the original ore, which experience indicates is very near the truth. The slimes are gathered up from beneath the magnetic separators; this material is very fine and not further separable. The loss has been assumed to be all soluble matter. The bulk of the loss is due to the roasting, where S is lost from FeS_2, oxidation being neglected.



FLOW-SHEET OF THE SECONDS TREATMENT.

However, in practice over-roasting rarely occurs. If the ore is under-roasted, then bluish-black particles will be seen. These bluish particles contain large kernels of unaltered pyrite, and are thus only weakly magnetic. The roasted ore particles should be very slightly sintered together. Any marked sintering or fritting together of the ore is due to the temperature, or time, of roasting being too great. Any sign of fusion of the bismuthinite points to the same bad conditions, which, however, with ordinary care are easily avoided. A sample of the ore may always be removed from the furnace, rapidly cooled, and examined. Under-roasting is the main thing to guard against, especially if the ore is coarse and very rich in pyrite. It is generally safer to give the ore a quarter of an hour longer in the furnace if there is any doubt. In practice any given lot of uniformly sized ore will have a constant time of roasting under normal conditions.

The roasted ore contains coarser as well as finer material than that started with. Pyrite decrepitates on heating, and thus a certain amount of fines is made; the cassiterite and quartz may also decrepitate to a certain extent. Again, in changing to the magnetic sulphide and oxide pyrite increases in volume, and thus ore coarser than that started with is found in the roasted product. This coarser portion is small in amount and is almost wholly magnetic iron-mineral. The pyritic tin-bismuth ore is the main product to be roasted, and it contains about 60% by weight of pyrite. This product loses about 11·5% of its weight in the roasting. In the change from FeS_2 to Fe_7S_8 the loss of weight is 23% of the original weight, while formation of oxides of iron involves further loss of weight. Thus an ore with 60% of pyrite should lose 14% of its weight if the above chemical change is completed. This reaction is, in practice, thus incomplete, and indeed it has already been mentioned that the coarser particles of the roasted pyrite contain kernels of the unaltered sulphide, FeS_2.

The whole treatment of the seconds may be summarized in the accompanying flow-sheet. The final products are numbered 1 to 7, and will be discussed in order.

Product (1) has already been considered. Products (2) and (5) consist of the strongly magnetic roasted pyrite, which carries some of the valuable minerals. This is the weak part of the process, as it is impossible to avoid a little sintering together of the ore-particles during the roasting. Moreover, the bismuthinite in the ore is closely associated with the pyrite, and the original seconds contain such composite particles in appreciable quantity, and these carry their bismuth into the iron-products (2) and (5). This also explains how the pyritic wolfram from the seconds gives rise to bismuth-bearing roasted pyrite (2), and a very little tin-bismuth ore (4). These metals are brought into the pyritic wolfram from their association with the magnetic pyrite there present. It is found, without exception, that in the various wolfram products the impurities, tin and bismuth minerals, are proportional to the pyrite content. Chalcopyrite and cupriferous pyrites, which are also present in the seconds, form magnetic ore on roasting just as pyrite does, and thus copper is carried into the products (2) and (5). These products are sold together as a low-grade bismuth ore containing from 6% to 9% Bi. Product (3) is a marketable wolfram ore, though the tin and bismuth contents are high for this class of material. It averages 60% WO_3, corresponding to 80% of wolfram, the remainder being incompletely roasted pyrite, siderite, vesuvianite, and associated quartz, cassiterite, and bismuthinite. Product (6) consists of pyrite that is incompletely roasted and of composite particles of roasted pyrite with other minerals. Both of these constituents are necessarily only feebly magnetic; any wolfram left in the pyritic tin-bismuth product (before roasting) will also separate here. In general, the amount of this product compared with the amount of the well-roasted, that is, highly magnetic, pyrite (5), gives the best test of the efficiency of the roast for magnetism of the pyritic tin-bismuth product. From a perfectly-roasted ore this product (6) would be of negligible amount. This product contains WO_3, Sn, and Bi in large amounts, and is marketed as a mixed ore. Product (7) contains the bulk of the cassiterite of the original seconds together with some bismuthinite, appreciable silica and scheelite, and small amounts of pyrite, molybdenite, etc. Product (4) is similar, but is formed in very small amounts. This tin-bismuth ore, (4) + (7), may be re-concentrated in a small wet-dressing plant, where the grade of the tin-bismuth ore will be raised by the elimination of some of the silica. The high percentage of WO_3 in this product (7) is due to the scheelite present in the original seconds accumulating at this point.

The table on the previous page gives a typical result obtained by the foregoing processes on a parcel of seconds that had the following composition :

[illegible]	[illegible]	[illegible]	[illegible]
Cassiterite ...	14·9,	"	11·8% Sn.
Wolfram (and Scheelite)...	13·0,	"	9·7% WO_3
[illegible]	[illegible]		[illegible]
Silica, etc., insol. in acids	8·2		
Pyrite	[illegible]		
Magnetite ...	10·5		
Other soluble matter ...	3·5		
	100·0		

In the above analysis some of the rarer constituents, as molybdenite, siderite, vesuvianite, are included in the insoluble in acids and the other soluble matter figures, while the division in amount between pyrite and magnetite is somewhat rough. The analysis will, however, indicate the complex nature of the ore treated.

From the table it will be seen that a resolution of the seconds into marketable products has been effected, but considerable losses of the valuable metals occur through the sintering that takes place in the roasting. For example, the roasted pyrite is sold only as a bismuth ore, and thus 11% of the tin and 7% of the tungstic acid of the original seconds are lost.

ZINC AND LEAD IN FRENCH INDO-CHINA.

In our November issue we quoted an article on the coal deposits of Tonkin, and in the February issue one on the mineral deposits of Annam and Laos, both extracted from articles in the *Far Eastern Review*. Another article in the same paper gives information about metallic mines, particularly zinc mines, in Tonkin. We quoted a United States Consular Report on the subject in October, 1917, but as the subject is one on which little information is available, we reproduce here the gist of the later article, though it, to some extent, covers the same ground.

The development of metallic ore deposits in Tonkin since 1906 has been noteworthy. Before that date hardly anything was done, and the old workings had been quite forgotten. The mines at Trang-da, Lang-hit, Thanh-moi, Cho-dien, and Yen-linh commenced production in 1905, 1906, 1907, 1908, and 1909 respectively. The accompanying table gives particulars of the output in 1916. In the article quoted in our issue of October, 1917, the results for 1913 were given.

Before the war the Tonkin zinc mines sent the whole of their output to Europe. Generally the richest ores were treated in Belgium, and the remainder in Germany. During the first few months of the war it was possible to send a few shipments to France and England, but at the end of 1915 freights had risen to such proportions that to send further shipments to Europe became impossible. Then came Japanese buyers who took over the production on terms advantageous enough for the exploiters of the mines, but even more for Japanese industry. Probably the cost of freight to Europe will remain high for a long time after the war, and it is possible that Japan will remain the principal buyer of the zinc ores. The question of erecting smelting works on the spot is being considered by the Japanese buyers.

The Trang-Da mine is situated on the left bank of the River Claire in the hill of Fort Giovaninelli. This hill is over 200 metres high, and dominates the town of Tuyen-Quang, situated on the opposite bank of the river. The situation of the mine is exceptionally favourable, as the workings are only a few hundred metres from the wharf where vessels of 60 to 100 tons are loaded. This mine was formerly worked by the Chinese, who appear to have found galena abundantly in certain parts. It was re-discovered in 1905, and work was commenced upon it in 1906 by the Société Civile de la Mine de Trang-Da. Since then it has yielded about 90,000 tons of calamine. Both underground and open-cut workings are employed. Since 1916 the mine has been worked for galena mixed with iron pyrites and a little blende. The calamine is cal-

PRODUCTION OF THE ZINC MINES OF TONKIN FOR THE YEAR 1916.

Name of the Mine or Mining District	Province	Production	Export	Average Content of Ore	Observations
		Tons	Weight in Tons	%	
Trang-Da	Tuyen-Quang	10,900	11,900	Variable	Half of the production is calamine containing 50% zinc, the balance containing about 38%.
Yen-Linh	" "	3,760	2,210	48	The ore is calamine exported to Japan.
Lang-Hit	Thai-Nyuyen	16,175	9,400	50	The production is ⅓ calamine to ⅔ blende. Exports: Calamine 3,000, Japan; Blende 3,000, Japan; Blende, 3,200 America.
Cho Dien	Bac-Kan	12,200	10,800	51	Calamine is the product. Exports: Japan 6,800 tons; Swansea 4,000 tons.
Thanh-Moi	Lang-Son	1,750	1,550	Calamine 56 Blende 52	Consisting of ¼ calamine and ¾ blende. Exports Japan 250 tons, United States 1,300 tons.
Poe-Van	Tuyen-Quang	3,240	1,600	52	The ore is calamine, which was exported to Japan.
Results of prospecting in various areas of search, and concessions.		800	730	52	
	Totals	48,825	38,190		

cined on the spot and the sulphides are concentrated.

The mines in the region of Lang-Hit, 17 kilometres to the north of Thai-Nguyen on the left bank of the Song-Cau, were formerly the site of important native workings. Re-discovered in 1905, they were immediately exploited again. Three deposits are actually worked by the Société Minière du Tonkin, a limited company with a capital of 2,000,000 francs in shares and 3,000,000 francs in bonds. The deposits, going from south to north, are the Lang-Hit, Mo-Ba, and Bac-Lao. These are connected with the Lang-Hit river, the point of shipments for their products, by rails and cableways. The ores are sent from this point to Haiphong in sampans along the Song-Cau. The construction of a railway of one metre gauge has been recently undertaken, connecting the mines of Lang-Hit to those of Phan-Me, and there is also under consideration the construction of a railway from Phan-Me to Thai-Nguyen and Dong-Anh which will permit of the transport of the products by rail to Phu Da-Phuc where they can be shipped in boats of about 100 tons. The country is constituted—as at Trang-Da—of a mass of limestones and primary schists. At the Lang-Hit mines the mineralization, calamine and blende, with accessory galena, is in parallel fractures, and in strata sometimes interstratified among the former and sometimes cutting across them. In some instances secondary fractures cross the general lie of the deposit and especially rich ground is found at the points of intersection. The region of Lang-Hit has produced, since the commencement of its exploitation, about 39,000 tons of ore of which 26,000 tons were calamine and 13,000 blende.

The Mo-Ba was opened for working in 1911. In the limestones near the contact with schists there is found blende, calamine, and a mixture of the two. The production from Mo-Ba has been 22,000 tons, half blende and half calamine, since 1911.

The Bac-Lao group have a rich mineralization of calamine and blende in a very dense network of veins. In the neighbourhood of the veins there are low-grade deposits of zinc ore, and with a view to treating this a roasting plant has been constructed at Lang-Hit Fleuve. Bac-Lao has produced, since the commencement of its exploitation in 1909, 27,000 tons of calamine and 10,000 tons of blende.

The ores from the three workings at Lang-Hit, with the exception of the blende and galena, are sent to Lang-Hit river, where they are calcined. At Lang-Hit river there is also a works for making oxide of zinc, producing two tons of oxide containing 70% of zinc per day. The production of the Lang-Hit mines from 1907 to 1916 has been 98,000 tons of ore, of which two-thirds were calamine and the remainder blende.

The mining region of Cho-Dien is 18 kilometres to the south-west of the Babe lakes and 20 kilometres east of Na-Don, and is on the Song-Gam, 12 kilometres up stream from Chiem-Hoa. The Song-Gam is navigable from Na-Don down-stream by sampans of from 10 to 15 tons. At Tuyen-Quang these latter are discharged into boats of from 50 to 100 tons. The delivery of products is from Na-Don. To connect this point with the mining region it has been found necessary to construct a railway 35 kilometres long. The construction of a work of this importance to serve a calamine mine is, perhaps, unique throughout the world, and is only justified by the immense richness of the mines of Cho-Dien. Workings cover a distance of about two kilometres, and are situated about 2,000 metres to the north-west of Ban-Thi, the terminal point of the railway where there are installed the furnaces, workshops, and the offices of the manager. The workings, in order from south-west to north-east, are those of La Pointe, Nam-Van, Phia-Khao, and Pao-Pen. The first two are situated on the southern slope of the plateau of which Phia-Khao and Bo-pen occupy the greater part. The workings are connected with Ban-Thi by a system of aerial ropeways and Decauville tracks. The deposit at La Pointe consists of a number of vertical veins. Certain of these veins have been followed for a horizontal distance of more than 100 metres and to a depth of 80 metres following the dip. The Nam-Van deposits are situated about 250 metres from and form an extension of those of La Pointe. In all characteristics they resemble the La Pointe and consist of a series of parallel veins. The principal vein, of which the thickness is from 0·5 to 2 metres, has already been worked for a length of 180 metres and for 20 metres following the dip. Three other veins of equal value but less continuous have been opened up. The Phia-Khao deposit is 800 metres north of those of Nam-Van. The ore is found in two fissures intersecting at an angle of 45° and at the point of intersection of a nature analogous to those at Nam-Van and La Pointe. The eastern fissure has been explored in depth.

The limestone peak of Bo-Pen, which contains the deposits of this name, is about 500 metres to the north-east of Phia-Khao. The principal deposit here is a vein or mass, having at the south an average workable thickness of 25 metres of calamine, and dividing toward the north-east into many veins of from 2 to 8 metres thick. The working of this deposit was commenced at the end of 1916. In addition to these deposits there are in the same region many outcrops of likely appearance, such as those of La Source, Lung Hoai, and Bo-Luong.

The production of calcined ore by the mines of Cho-Dien rose from 2,000 tons in 1914 to 8,500 tons in 1915, and to 12,000 tons in 1916.

Thanh-Moi is a station on the railway from Hanoi to Lang-So'n, 78 kilometres from Dap-Cau. The products from this mining region are delivered by rail to Dap Cau and from there sent to Haiphong in boats of 100 tons. The work of the Société Minière de Thanh-Moi, a limited liability company with a capital of 1,000,000 francs, is centred on the deposits of Long-Ro and of Quarter No. 3. The Long-Ro area, about 1½ kilometres to the north-west of Thanh-Moi, presents along a length of about 600 metres a series of pockets in the limestone rich in blende and calamine which have supplied since the commencement of the working from 6,000 to 7,000 tons of ore. The deposits of Quarter No. 3, situated 1,500 metres to the south-west of Long-Ro, are in the calcareous formation, and consist of a vein, showing rich zones between others of poorer ore. The proportion of blende to calamine is 1 to 3, the latter also containing about 4 grammes of gold to the ton. The production from this region has reached about 10,000 since its exploitation was commenced. Prospecting by the company has discovered at Long-Sai a vein of calamine and blende, and at the point known as kilometre 3 they have exposed two deposits of blende 3 metres thick.

The Société des Mines de Yen-Linh, a limited liability company with a capital of 700,000 francs, has been working since 1911 the deposits of the Kem mine, on the left bank of the river Claire, and contiguous to the mine at Trang-Da, which has already been described. Three deposits are being developed, those of Kem, Point 123, and Pia-Kha. The deposit at Kem is a contact deposit between schists and primary limestone running from north to south, but cut across by fractures running in all directions and at various angles.

The minerals consist chiefly of hematite with a ferruginous calamine which passes rapidly to sulphides with depth. Point 123 deposit, proved so far for 70 metres in depth and followed for about 100 metres of its length, is intercalated in the compact limestone and traversed by numerous faults filled with clay and calcite. The mineralization, varying from nothing to 2 metres of workable thickness, is in the top part a good calamine which turns below to blende. At Pia-ka the principal mineralization consists of brown hematite and calamine with galena and cerussite in a barytic and flinty gangue. The mines have produced since their commencement about 7,000 tons of saleable calamine.

There are many other deposits of zinc ore in Tonkin worthy of attention. On the Haut-Song-Gam, about 35 kilometres upstream from Na-Don, are the mines of Pac-Van, which produced, in 1916, 3,000 tons of ore: those of Bac-Lhung, Phuc-Ninh, Dia, on the River Claire on which the works are not yet sufficiently advanced; the mines of Cho'-Don, 10 kilometres south-east of Cho'-Dien, which have been made the object of investigation and in which exploitation is for the present subordinated to the creation of a line of communication, either towards the Song-Cau, or, preferably, toward the Song-Gam, for there they will be able to connect with the railway to Cho'-Dien; the mines of Phuc-Sam on the Haut-Song-Day, 30 kilometres as the crow flies east of Tuyen-Quang; the mines in the region of Na-ri, 25 kilometres east of Bac-Kan; those of Hung-Son near Thai-Nguyen, etc., etc.

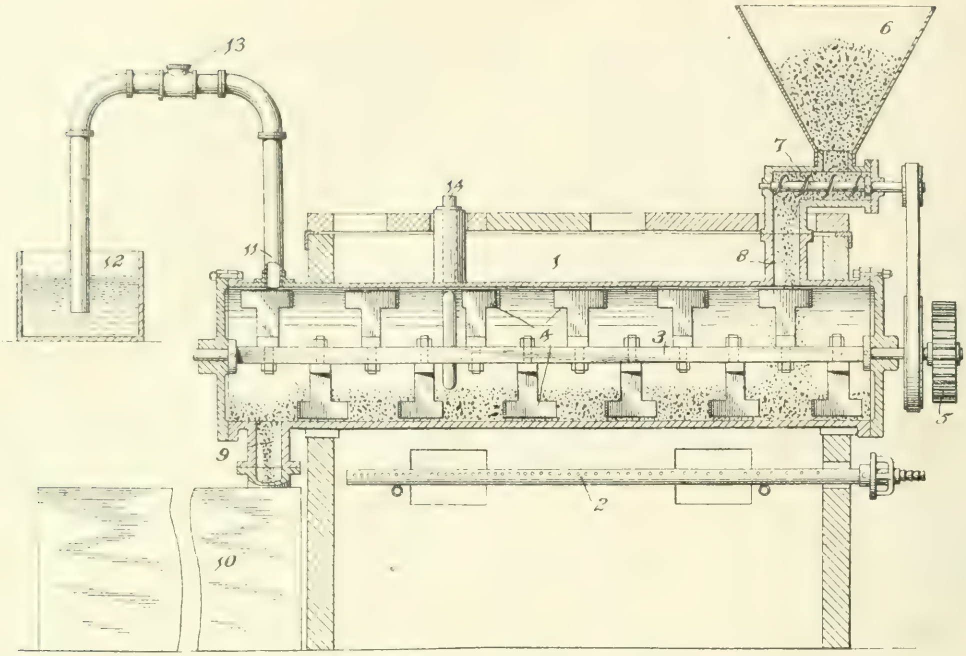
THE GANELIN CHLORIDE PROCESS.

British Patent 20,761 of 1918 (135,968) contains the latest information relating to the Ganelin or "chloride" process, which is being tested by Amalgamated Zinc (De Bavay's) Ltd. on silver-lead-zinc middlings, etc., at Broken Hill. The patentees are the company and Solomon Ganelin, of Brooklyn.

This method consists in mixing such material with sufficient zinc chloride to form with the lead present in the ore chloride of lead and sulphide of zinc by double decomposition and heating the mixture just about or below visible red heat in a closed retort or other furnace with the exclusion of air and leaching out the so formed lead chloride with boiling water. In the working of this method it has been found that a certain proportion of the lead and most of the silver was not recovered, which gave rise to the belief that the fault lay in the inefficiency and limited sphere of activity of the chloridization operations. Closer investigations have shown that if certain precautions are adopted in the chloridization operations as well as in the leaching operation both the lead and the silver can be substantially completely recovered. With regard to the chloridization operation it has been found that, firstly, if insufficient zinc chloride is added arsenic and antimony sulphides will first be chloridized and distilled off, and that the lead sulphide present will only be decomposed by as much zinc chloride as there is excess over that amount necessary for the chloridization of the arsenic and antimony present, and that the silver sulphide will only be decomposed after all the three mentioned sulphides of arsenic, antimony, and lead are chloridized, or in other words if silver chloride should happen to be formed it will give up its chlorine radicle to the sulphides of arsenic, antimony, and lead, being itself reconverted into silver sulphide; secondly, when the ore is mixed with sufficient zinc chloride and even when some excess is present and the mixture is heated in a closed retort or roaster or in any other vessel in which the charge is resting without agitation only small layers of the mixture will be completely chloridized and larger quantities of the mixture as would be required for working on a commercial scale are not completely chloridized, due to the incomplete decomposition of the inner part of the treated mass in spite of a relatively high temperature and of much time used in the operation. But it has been found that if the mixture is agitated or mixed at the same time while it is being heated then the chloridization of the lead and silver sulphides of the mass is complete and takes place momentarily as soon as the mass attains the right temperature of about 400° to 500°C.

Furthermore, even if both the lead and silver sulphides are completely chloridized, the chlorides cannot be satisfactorily recovered from the charge if certain precautions are not taken in the leaching operations as well. From experiments it has been found that in the subsequent leaching operations the recovery of the lead chloride by the leaching solution was more or less variable, but in no case could the whole of it be removed while the silver chloride was generally not recoverable at all. It has been found that this is due to the fact that when the chlorides of lead and silver are brought into solution in the presence of zinc sulphide a portion of the lead chloride and practically the whole of the silver chloride are reconverted back into sulphides by the reaction of the zinc sulphide present and are thus not removed by the leaching solutions. The reversion into sulphides of the lead and silver chlorides has been found to be promoted and accelerated by the use of warm leaching solutions and by prolonging the period of contact between the ore and the leaching solutions.

The precautions and measures to be taken for the purpose of preventing the reaction between the sulphides in the ore and the dissolved lead and silver chlorides may be either mechanical or chemical. For example, the aforesaid reaction may be hindered or minimized by carrying out the leaching operation under such conditions that the temperature is maintained as low as possible, as by using very cold leaching solutions, and also by reducing the time of contact between the solutions and the mass to a minimum, such as by carrying out the lixiviation by percolation through thin layers of material. Or the reactions may be prevented altogether by the addition to the leaching solution of such substances as will prohibit the same. For example, the leaching solution (such as brine) may be acidified by the addition of from ½ to 1% of hydrochloric acid or of a suitable acid chloride salt (such as aluminium chloride). When conducting operations for the removal of lead chloride only, to the leaching solution may be added a small proportion (from 3 to 4%) of zinc chloride which will prevent the reaction of the zinc sulphide upon the lead chloride; while when proceeding to the removal of both the lead and silver to the leaching solution may be added substances which have a chloridizing or oxidizing effect upon sulphides, such as cupric chloride, ferric chloride, ferric sulphate, or per-acids and the like. Or further, the reactions may also be prohibited by treating the product preliminary to the leaching operation in such a way that the metal sulphides contained therein are coated with a thin film of sulphur such as for example by treating the product with a weak solution of ferric chloride or cupric chloride. The reaction between ferric chloride and sulphides, in which there is a reduction of the ferric chloride to ferrous chloride and the formation of chloride of the metal with deposition of free sulphur on the metal sulphide particles, is well-known. This film of



FURNACE USED IN THE GANELIN PROCESS.

sulphur isolates the metal sulphides of the mass and prevents them acting on the dissolved chlorides.

In the treatment of ores containing also zinc with the lead and silver it is possible to obtain not only substantially pure lead and silver but also zinc products from which spelter or commercial zinc products may be obtained substantially free from lead.

In adapting this invention to the treatment of mixed sulphide ores such as Broken Hill ores the requisite quantity of zinc chloride is taken for the conversion into chloride of the sulphides of lead and silver present as well as of antimony, tin, and arsenic (when such metals are present) and preferably a small excess of zinc chloride is employed beyond the quantity so calculated. When the double chloride of zinc and sodium is employed the amount required will be such that the chlorine of the zinc chloride will be sufficient to effect the chloridizing of the lead and silver together with antimony, tin, and arsenic if present. This zinc chloride or its double chloride with sodium is then mixed with the ground ore, and the mass is agitated and heated without access of air to a sufficient temperature (from about 400 to 500°C.) to effect the chloridization of the sulphides of lead and silver. When the operation is carried out upon a commercial scale, the reaction between the zinc chloride and lead and silver sulphides is only complete when the charge is thoroughly mixed and agitated during the course of the heating operation, and for this reason it is not only possible but economically advantageous to make the operation a continuous one. When arsenic, antimony, and tin are present the chlorides of those metals are formed and are allowed to volatilize off and are thus removed. The residue contains the lead and silver in the form of chlorides, other metals present being left materially unchanged, the sulphides of zinc and copper not being decomposed, while iron and manganese silicates occurring in the ore are but slightly decomposed ; any iron and manganese chlorides which may be formed will react with the sulphide of lead, chloridizing the same and themselves being re-converted into sulphides, so that in the residue lead and silver are the principal metals present as chlorides if no material excess is added of the reacting chloride, which should be avoided.

In carrying out this heating operation an externally heated drum, tube, or furnace is used such as is illustrated in longitudinal vertical section in the accompanying drawing. The apparatus comprises a drum or cylinder 1 enclosed within a furnace structure and heated by any suitable means such as the gas burners 2. Within the drum is a rotating shaft 3 carrying stirrer blades 4, which are so arranged as to cause the material in the drum to be progressed from the inlet to the outlet thereof. The shaft and stirrers are suitably driven as by gearing 5 from any convenient source of power and at a speed appropriate for the reaction which takes place within the drum. The charge is fed into the drum from the hopper 6 by means of the worm 7 driven from the shaft 3. The material enters the drum through the inlet 8, and leaves the drum through an outlet 9 at the opposite end, which is sealed, as shown, by being connected to the chamber 10 so as to prevent access of air ; a vent is provided leading off any volatile fumes which may be sealed by having its outlet dropping below the level of a liquid in a vessel 12, a release valve 13 being provided in the vent pipe 11 ; a thermometer 14 is provided for indicating the temperature within the drum. In such an apparatus, the mixture of ore and zinc chloride is heated without access of air to a sufficient temperature to effect the double conversion of the lead and silver sulphide into chlorides and the zinc chloride into sulphide. This temperature is, in practice, about 400° to 500°C or higher. The apparatus described is particularly advantageous in that it makes the chloridization operation a continuous one and permits heating of the mixture in an economical manner, the material being kept in the form of a stream which moves along the bottom of the apparatus where it is hottest, so that the heating of the charge is rapidly effected. The simultaneous mixing and agitating of the charge is essential for the complete and rapid chloridization of the charge.

The leaching of the chloridized product may be directed to the extraction of the lead and silver chlorides together or separately as may be desired. In proceeding to the extraction of both the lead and silver together, the leaching may be effected with cold concentrated chloride solution, such as brine, or with sodium thiosulphate, care being taken that the temperature is maintained as low as possible and that the period of contact between the ore and the pregnant solution is reduced to a minimum. For this purpose the leaching is preferably effected by percolation through thin layers. Similarly both the lead and silver chlorides may be extracted together by leaching with a concentrated brine solution containing a substance which has a chloridizing or oxidizing effect, such as cupric chloride or ferric chloride. The latter, ferric chloride, is preferable because the presence of copper interferes with the subsequent recovery of the lead.

When it is desired to extract the lead and silver separately it is necessary to extract the lead chloride before the silver chloride, and in this case precautions are taken to prevent the reversion only of the lead chloride to sulphide. For this purpose it is preferred to add to the leaching solution, such as hot concentrated brine, a small proportion (from 3% to 4%) of zinc chloride which will prevent the reversion of the lead chloride to sulphide. This solution will remove substantially all the lead chloride, and being hot and not containing any substance to prevent the sulphidization of the silver chloride will at the same time convert all of the latter into silver sulphide which will be left with the residue. The silver is thereupon extracted by any suitable means, such as by a cyanide solution or by a brine solution containing some ferric chloride (2% to 4%). In the extraction of the lead and silver by the use of ferric chloride and the like it practically makes no difference if the metals are contained as chloride or as sulphide. In both cases they are extracted as chlorides with a solvent containing only a small percentage of the perchloride.

Alternatively the lead and silver chlorides may be removed separately by first leaching the chloridized product with hot water, leaving the silver chloride as sulphide in the residue, and subsequently leaching the residue with a suitable solvent in the cold, leaving the same in contact with the leached mass for a minimum amount of time to avoid the conversion of the silver chloride into sulphide.

The solution obtained from the leaching out of the lead chloride with a hot brine solution to which has been added a small proportion of zinc chloride is allowed to cool for the crystallization of the lead chloride which is then removed. The solution is then re-used for the treatment of fresh product obtained as hereinbefore described. The crystals of lead chloride are dried and fed to a bath of molten zinc chloride to which has been added a certain amount of metallic lead. Metallic zinc is then added to this bath which reduces the lead chloride to metallic lead, and successive additions of lead chloride and metallic zinc are continuously made. The metallic lead is tapped off when there is an excess of lead chloride, and the zinc chloride is tapped off when there is an excess of metallic zinc, thereby obtaining two products, metallic lead free from zinc on the one hand and zinc chloride free from lead chloride on the other hand.

When the lead chloride is leached out with a cold solvent solution or is otherwise obtained in solution, the lead is precipitated therefrom by means of metallic zinc in the form of a spongy mass, the zinc going over in solution as chloride. This spongy lead has hitherto not been found to be readily convertible into commercial form, but it has been found that if it is fed into a bath of molten zinc chloride or of the double chloride of zinc and sodium it can be conveniently remelted and converted into a marketable product.

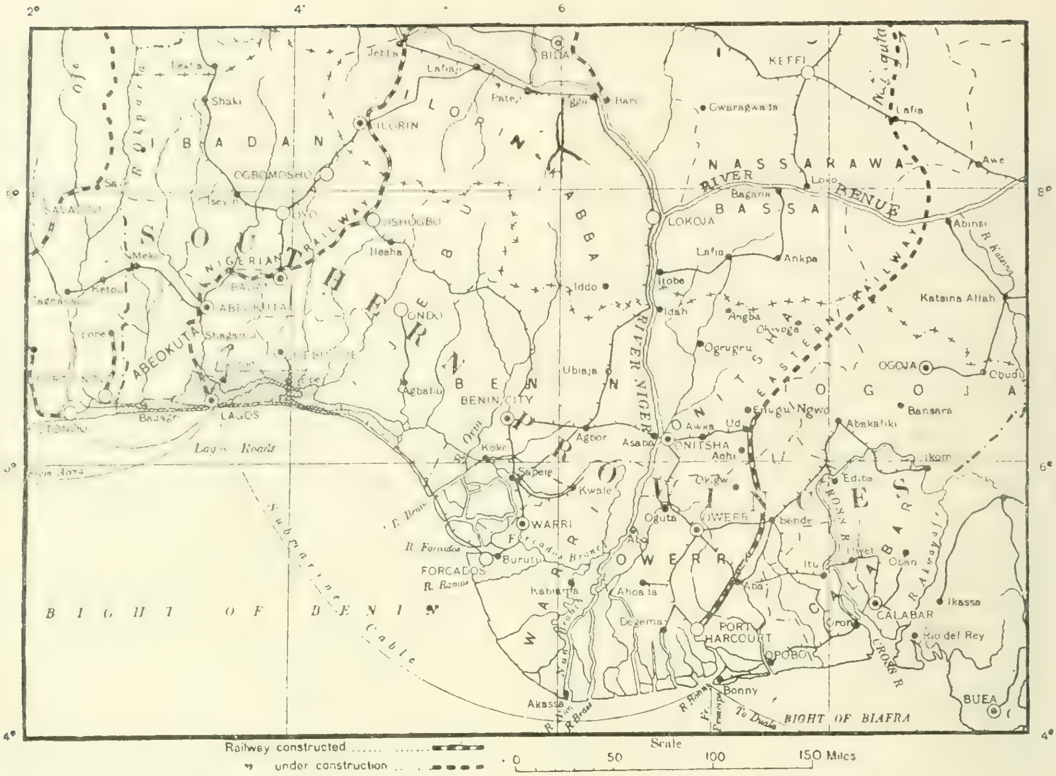
The zinc chloride obtained in solution is recovered therefrom by evaporation and is re-used in the chloride solution operation. In case the zinc chloride is obtained in a brine solution it is recovered in the form of its double salt with sodium chloride. It has been found that when a brine solution containing zinc chloride is evaporated, it first separates the excess of sodium chloride contained in solution over and above that amount required for the double chloride of zinc and sodium, while this double salt being a very soluble salt is left in solution and is recovered by further and separate evaporation to dryness after the separated excess of sodium chloride has been removed.

NIGERIAN COAL.

In a Government report by Sir F. D. Lugard on the administration of Nigeria from 1912 to 1919, some information is given with regard to the development of the Udi and other coal deposits. In January, 1917, we gave an account of the Udi coalfield, with an analysis of the coal, mentioning that its discovery was due to A. E. Kitson. Sir Frederick Lugard's record is more from the political and labour point of view. We quote it nearly in full.

The existence of coal in the Udi district had been known for some years, as well as that of lignite in the districts on the western banks of the Niger. The latter being more accessible were first investigated. It was first suggested that a briquetting plant should be erected. The expense was, however, too great, and the cost of transporting the briquettes from the proposed factory to the Niger, and thence to Lagos or Baro for use on the railway, rendered it doubtful whether that form of fuel could compete, at the same calorific value, with imported coal. Its suitability for river steamers was more probable, but Government transport on the river had dwindled since the advent of the railway. The Niger Company, which owned a large fleet, obtained the lease of a lignite field at Okpanam, aud sent out an expert to examine it, but after his report was received they did not pursue the matter further.

Early in 1912 a survey of the district between the Niger and Udi was undertaken by Government, with the object of building a railway 60 miles long, and a considerable sum was spent in borings to ascertain whether the coalfield approached nearer to the river. Applications for leases of portions of the coalfield were at this time under consideration. The difficulties and cost of Niger navigation made it sufficiently obvious that it would be much more advantageous to bring the coal down to the seaboard if it were possible to find a port, the more so that such a railway would open up a country exceedingly rich in palm produce, and would be a remunerative investment apart from the coalfield; whereas a line from Udi to Onitsha—about 150 miles up the Niger—would be of comparatively little value. The navigation of the Niger had become increasingly difficult of late years, and only shallow draught vessels could reach Onitsha except during three months in the year. Investigations led in December, 1912, to the dis-



MAP OF SOUTHERN NIGERIA, SHOWING POSITION OF THE COALFIELDS.

covery of a suitable harbour now known as Port Harcourt, and it was decided to build a railway from that port to the coalfield. The line reached Udi in May, 1916, and the first truck of coal arrived at the seaport at the end of that month. Meanwhile considerable development had taken place. The Government had decided that the coalfield should be retained and worked as a Government monopoly, at any rate until full statistics had been obtained of the extent and value of the deposits and the cost of working. The coal outcrops on the side of a short range of hills, running north and south, which fall steeply to the general level of the country traversed by the railway. The rail-level here is 774 ft. above datum at Port Harcourt, and the coal seam where first located was at 1,048 ft. A small staff was organized under two experienced men, selected by Professor Cadman, who was nominated as consulting engineer. They arrived in October, 1914, and at once selected the most suitable place for driving an adit into the hill-side. An inclined plane was constructed, down which the coal cars should run and deliver the coal into the railway trucks below. Surface and underground labour gangs were organized, and by the time that the railway was sufficiently completed to carry the coal to the coast, 9,207 tons were ready stacked.

The coalfield is situated near the large native town of Enugu, and the surrounding country is densely populated. The natives, under the sympathetic handling of Messrs. Leck & Haynes, came forward in large numbers, and there has never been any lack of voluntary labour, in spite of its arduous nature at high temperatures underground. They soon learned to appreciate payment by results, and the present wage is fixed at 3d. to 4d. per car of 5 to 6 cwt. Natives are gradually being trained to replace Europeans. Quite recently the re-lining and heightening of the main drift, including the extraction of the timber and the blasting out of two feet of stone from the floor and re-timbering, was successfully done chiefly in night shifts, under the sole supervision of a native foreman engaged in February, 1915. A section of the mine has also been placed under a native, with good results. A convict prison has been established at Enugu, and the prisoners are employed on suitable surface work.

The friable nature of the overburden necessitated an unusual quantity of pit-props and continuous roofing, adding considerably to the cost of the coal. These were supplied from the mangrove forest surrounding Port Harcourt and sawn on the spot. Exploration continued *pari passu* with development. It was found that the coal dipped downward, and Mr. Hayes, ascending the valleys of the two small streams Obweti and Iva on either side of the great spur in which the workings are situated, located the outcrop at two points separated by only 2,000 yards, where the neck which connects the spur with the main range is narrowest. Both these points, being at approximate rail level, were accessible by sidings from the main railway, and he submitted a scheme for driving a tunnel in the coal between them, and excavating on the rising gradient of the coal stratum towards the present adit, so that the whole underground workings will have a natural drainage outward. The line of this tunnel would mark the point at which the coal seam dips below the general ground, or rail, level. Throughout the spur coal will be excavated and loaded on cars running on a down gradient to rail level; on the other side of the tunnel they must ascend. It is estimated that there are about twelve million tons of coal in the area taken up. The siding to the Iva Valley (4½ miles) was at once put in hand, and was completed in November, 1917. The coal here is at the level of the siding and progress has been made in driving the main horizontal working, while winning the coal from the districts on the rising gradient to the left of it. A labour camp, and houses for the staff, were erected. It is not at present intended to start work on the Obweti side.

The present output is over 400 tons a day, with a maximum of 768. It can be increased indefinitely according to the demand, the supply of cars, and the capacity of the railway to handle it. An output of well over 200,000 tons is anticipated in 1919, and there should be a surplus, when Government requirements are satisfied, of 8,000 tons a month for sale to the public. The cost of winning will, of course, be decreased the greater the output, and by the installation of proper machinery, and the employment of native skilled labour. Meanwhile the high market price of coal has enabled the colliery to pay for all development work out of earnings, and in addition to contribute about £47,400 to revenue. As soon as it is possible to procure the machinery, the electrification of the mine will be undertaken, and proper haulage engines and fans will be installed.

The pit-mouth cost, exclusive of interest on capital outlay for development and exploration, has varied from 9s. 2d. to 7s. 2d., the Iva Valley output being much cheaper. Railway freight to the port and handling charges there add 19s. 6d. a ton. The cost f.o.b. at Port Harcourt may therefore be put at 28s. a ton. It fetched 33s. a ton during the war. The normal cost of freight to Lagos cannot at present be calculated accurately owing to the abnormal cost of shipping. The cost by vessels chartered by the Admiralty is put at 24s. 6d. a ton, with a margin of profit. The shipping line charges were 40s. a ton. The cost to Government departments ex wharf Lagos in 1917 was 58s. 6d., reduced to 56s. in 1918. The value of the coal for steam-raising purposes is estimated at 80% of the best Welsh; this percentage can probably be considerably increased by the adaptation of the fire-boxes, since Mr. Lumley, Superintendent Engineer (Marine), has discovered that the coal requires a large amount of air to obtain the best calorific value. Forced draught merely results in waste. Before the war the price of Welsh coal landed at Lagos was about 37s., at which price the Udi coal cannot compete until the cost of winning has been reduced by better machinery, larger output, and cheaper ocean transport. Welsh coal is practically unprocurable now, but commanded 105s. a ton at Lagos in 1916. At that figure the relative price of Udi coal would be 76s. 2d.

To the energetic development before the war of this coalfield and the railway which serves it, Nigeria owes more than is easily calculable. Without it the Western Railway, which is earning £1,200,000 a year, could not have been kept running at full capacity, even at enormous expense, and the supply of oleaginous produce and of tin, so much needed in the United Kingdom, would have been greatly restricted, the exploitation of local timber would have been impeded, and the administrative machinery would have suffered the greatest inconvenience. Great as these direct advantages are, the indirect and permanent results are hardly less. A particularly turbulent tribe has been taught to seek labour for wages, and has earned not less than £34,000 in cash, with which to purchase imports, and improve its standard of living. The new railway has been able to pay its way, instead of being a burden on the depleted revenue; a new outlet has been afforded for native skilled labour with a new means of training it, and a coin currency has been promoted through a large and densely-populated district.

The prospects of the colliery are very promising. The spur cut off by the tunnel to be constructed from Iva to Obweti should continue to be worked by Government for its own requirements. Leases of other areas can be granted to private enterprise as soon as the railway is able to provide adequate haulage, and the wharf and other arrangements at Port Harcourt are able to cope with the traffic. Government is now in a position to fix a reasonable royalty from actual knowledge. The chief accountant has calculated that at present the working costs of a company, including directors' fees, etc., would be 8s. 4d. a ton, and that with a pit's mouth price of 10s. a dividend of 8% would accrue on the capital outlay with 1s. royalty, or 12% with a royalty at 6d. The profits would be increased by a greater output and better machinery.

Ferro-Concrete at Modder East.—The January *Journal* of the South African Institution of Engineers contains a paper by Thomas Blandford describing a ferro-concrete dam employed for shutting off an inrush of water at Modder East. This dam was constructed in the 3-19 rise at No. 1 shaft, for the purpose of controlling and closing off a feeder of water which yielded approximately one million gallons per day at a pressure of 500 lb. per square inch. This outburst was met in the dyke through which the rise was being driven, and was found to be coming from a vertical fissure striking north and south. This fissure was filled to a large extent with soft clay, but evidently not sufficiently solid to resist removal by the water under pressure, with the consequence that as soon as the water was tapped in small quantity a portion of the clay filling was quickly washed out; furthermore, the dyke material adjacent to the fissure, being of a broken and loose nature, was displaced by the flow of the feeder until a cavity about 18 in. wide, 6 to 10 ft. long, and 10 to 15 ft. high was created at the south top corner of the face. Fortunately the dam was constructed and finished before this continuous stripping action was able to extend across the whole width of the face, thereby preventing a further increased flow of water.

As soon as it was found that any temporary measures for reducing the quantity of water were useless, work was immediately taken in hand to build a ferro-concrete dam. A good concrete, consisting of 1 cement, 1 sand, and 2 broken stone (dyke material on site), was well rammed into the face to a thickness of approximately 4 ft. No hitches for support were cut in the rock, but a series of forty 1 in. steel pegs were driven to a depth of 6 to 9 in. into the rock in two rows around the perimeter of the drive, such pegs projecting a distance of about 1 ft. 6 in. into the mass concrete. In addition to this, two rows of ½ in. bar iron, one vertical and one horizontal, the bars being about 1 ft. apart, were embedded into the concrete during construction and tied up by means of wire to the above-mentioned pegs, thereby forming a double grille system of reinforcement. In this way a thoroughly strong wall was obtained.

The feeder of water was confined behind the concrete to as small a channel as possible with the aid of 21-gauge steel sheets, and released through two 6 in.

pipes fitted with stop valves. By this means it was possible to place the concrete in position correctly without any interference from the water. Six 1½ in. cementation pipes were also built in the dam for the purpose of filling and solidifying the fissure and the subsequent testing of the ground in advance. While this work was in progress three release holes were drilled into the hanging wall from the front of the dam at an angle of 45°, thereby intersecting the fissure approximately 12 ft. above the hanging of the rise, water being tapped in each of these holes.

The work of construction of the dam occupied two days, being commenced on August 14, 1919, and completed on the 16th, after which it was allowed to set for three days. During this period the feeder was flowing freely from the 6 in. drain pipes. Injection was then started on the 19th, and continued until the 27th, when all the pipes in the dam had been solidly closed with cement, and also two of the release holes in the hanging wall. At this stage approximately half the original feeder was shut off, but, owing to shortage of cement, it was not deemed advisable to close it all off, as there was no cement on hand should anything unforeseen take place by totally closing off the water, taking into consideration the short period that had been allowed for the maturing of the concrete. If sufficient cement had been available the work would have been completed in one operation at this stage. Sufficient cement was obtained on September 1, and injection continued until the 2nd, when all the release holes in the hanging wall were completely finished, thus effectively shutting off all water.

A quantity of 4 tons 14 cwt. of cement was used in the concrete construction. A quantity of 25 tons 9 cwt. of cement was injected at pressures ranging from 25 lb. to 220 lb. per square inch, giving a total quantity of 30 tons 3 cwt. cement used for closing off the fissure. The total time occupied upon the construction of the dam, including the necessary injection of the fissure, to enable the feeder to be completely shut off, was 14 days. The total cost entailed in the construction and injection of the dam was £397. 16s. 8d.

After completing the dam and shutting off the water, the mode of procedure consists of testing the ground in advance by means of bore-holes, and, if additional water-bearing fissures are cut, cementation is conducted, so that the drive may subsequently be extended through the water zone without encountering water, the ferro-concrete dam being in the first place removed by blasting.

The chief advantage of this system of dealing with an inrush of water, apart altogether from its small cost, lies in the fact that, whereas the water is easily dammed back and placed under control, it is unnecessary to abandon the drive altogether, as would be the case if any one of the ordinary types of underground dams is used. Furthermore, if desired, it is possible to again tap the feeder of water for industrial purposes by boring from the drive into the ground to a point in the fissure or fissures which is beyond the limits of the cemented area that envelopes the drive throughout the water-bearing zone.

Steaming Amalgamating Plates.—In the issue of August last year we reproduced a discussion at a meeting of the Chemical, Metallurgical, & Mining Society of South Africa on the steaming of amalgamating plates, especially in connection with the prevention of the escape of mercurial fumes. That society appointed a committee, consisting of S. H. Pearce and J. E. Thomas, to investigate this question. The report of this committee was presented at the meeting held in November. We quote this report herewith.

A great diversity of opinion exists in connection with steaming, starting from those who are of opinion that by reason of danger to health it should be prohibited, down to those on the other side who equally emphatically declare it to be a necessary operation. In between milder expressions come from those who advocate steaming as being a saving of labour, or advisable for better amalgamation, and from others who suggest various methods of dispensing with the operation. Leaving out the extremists on both sides the question resolves itself practically into a question of labour as well as health.

Under certain conditions amalgam will accumulate on plates which requires a good deal of labour to remove unless steam is used to soften the deposit. This labour will vary from scouring in various ways to the use of chisels, according to the time the deposit has had to harden. The conditions of accumulation run in fairly definite lines, apart from voluntary accumulation for purposes of regulating the output, a matter on which no evidence can be given. Roughly speaking the involuntary accumulation may be divided into two classes, that due to the mill methods employed in the first place, and that due to force of circumstances in the second, with of course an intermediate link of a combination of both.

The mill methods class will mean the individual system adopted by the man in charge, whereas circumstances will include the design of plant, besides any idiosyncrasy of the ore dealt with. Thus a variety of method is shown in the condition of the plate (that is, whether hard or soft), the frequency of dressing, and the grade of plate, which all have a relation to each other. For instance a plate that has a comparatively large amount of amalgam left on it will be capable of receiving a liberal allowance of mercury when dressing, and will remain soft and in a good receptive condition longer than a comparatively bare plate under equal conditions. To preserve this quality, such plates will be scraped but lightly, and the result is an accumulation which produces a high steaming return. The man who adopts this method will obtain a high return by amalgamation with the least labour, but will probably be accused of holding gold back, and may be reckoned a culprit as far as advocating steaming is concerned.

The next example may be taken where a similar condition of plate is arrived at with a minimum of amalgam left. This will require more frequent dressing to prevent hardening up, and hard scraping every day; probably also a thorough scouring, say every other day. This man will also have a high amalgamation return with a maximum of labour, and the conscious rectitude of a humanitarian who does not advocate steaming. A variety of the foregoing is found in those who prefer to scour less often, but make a big job of it once a month, in place of steaming.

Another variety of method is adopted by one group where a saving of mercury consumption is effected by the use of blankets, etc., and the resulting concentrate ground up in barrels, but this method deserves a special description and would form the basis of an excellent paper on its own. It is not proposed to go further into methods, because a difference of opinion exists as to whether a high extraction by amalgamation is desirable or not, in view of the labour required and idle capital involved in laying out the plant. This doubt frequently entails a neglect of the fundamental condition of maintaining a proper plate surface and retaining the free gold there, instead of in various lodging places on its way to the cyanide plant.

As regards circumstances, the first variety exists in the ratio of water to rock crushed. On the one hand there is a plant with launders having insufficient grade, where the water ratio is necessarily high. On the other hand there is a more modern plant with probably excess launder grade but economical in plate area. In the first case there may be a ratio of perhaps 8 to 1, and in the second as low as 2 to 1. These differing conditions will affect the grade of the plate, 18% being necessary in the one case compared to 8% in the other. Apart from the overcrowding of the plate area, this extra grade causes difficulty in control of plate condition. With a bare plate there is nothing to arrest the mercury in its tendency to run off into the launder, so a choice has to be made between leaving a deposit or very frequent dressing. In any case amalgam at the top of the plate will harden more rapidly and require removal with more labour whether by steaming or by other means.

The question of shaking plates versus stationary is practically settled. There is little difference between the two as regards recovery by amalgamation. Shaking plates require less grade and provide for a more equal distribution of the pulp, but require power and maintenance, which perhaps more than balances anything in their favour. Shaking plates also have a tendency toward accumulating amalgam, similar to a plate with a steep grade.

The degree of alkalinity of the mill water also affects plate accumulations in that an excess of lime hardens the amalgam. In some mills, owing to the varying acidity of the rock, the alkalinity is difficult to regulate, and in these cases a scrape made in the usual way leaves a considerable quantity behind and causes a pleasant surprise on steaming. Under such circumstances it is quite possible that a hammer and chisel may be required if the plate be not heated. On the other hand cases are not unknown where neglect to neutralize the acidity has resulted in stripped plates. The fineness of the gold amalgamated is also a minor factor. Coarse gold particles do not accumulate and are easily removed, but the reverse is shown in the finer particles. Thus it follows that the higher percentage amalgamated will generally be obtained from a larger proportion of such fine gold, and result in greater tendency toward accumulation. An instance of this is shown on a plant where a coarse mesh is used in the mill and the pulp passes over plates before being reground. The mill plates show practically no return by steaming, whereas the tube-mill plates accumulate fairly heavily under similar conditions.

The foregoing does not pretend to deal with all the factors involved in the question, but is merely intended to explain why a difference of opinion on the subject should exist. Dealing, however, with the facts from a technical point of view, it may be said that steaming can only be considered as a labour-saving device, which enables plate acccumulations to be removed with the least difficulty, as otherwise, in the absence of a mechanical device to take its place, a large expenditure of labour would be incurred in most instances. This is a matter on which a difference of opinion is to be expected, in fact, opinion differs considerably even among those most interested.

However, there is no doubt, as with many other ailments, idiosyncrasy plays a very large part, and certain men suffer from some sort of indisposition after taking part in the operation. In many instances there is a probability of mercurial affection, but in at least as many others it is equally probable that the indisposition is due to over-exertion and poor health. Nor can it be asserted that steaming is the chief cause of mercurial poisoning because the practice of eating meals with unwashed hands appears far more dangerous as a means to conveying mercury into the system. These, however, are matters on which medical men should speak; but in the absence of medical evidence to the contrary it is not considered by the committee, if proper precautions are taken, that steaming should be discontinued.

The precautions advised are well known, and are as follows: Provide ample ventilation for plate houses; lead exhaust steam from plates to the outside of the building; select men for the operation who are known to be immune; divide the work as much as possible to prevent over-exertion; provide wash basins, mouth washes, etc., as recommended.

Weighing Gold Bars.—At the November meeting of the Chemical, Metallurgical, & Mining Society of South Africa, Harry R. S. Wilkes read a paper entitled "Some Possible Causes of Discrepancies between Mine and Buyers' Weights of Gold Bars." Differences between the mine weights of gold bars and those of the same bars recorded by the buyers at home, before melting, often occur; and further differences, after melting, generally are recorded. This is well known, as is also the fact that these differences are apparently all in favour of the buyers. The account sales usually give three records of weights: (1) mine weight, (2) London weight before melting, (3) London weight after melting. It is with the differences between these that the author deals.

There are two general methods in use on the Rand for pouring gold: (A) pouring without slag, after skimming, (B) pouring under a slag cover. The former is most suitably employed in dealing with gold of high fineness, the latter when melting gold containing much base metal.

The correct condition for pouring gold is that it shall be done at as low a temperature as is compatible with slow pouring. The estimation of such a temperature is a matter of considerable judgment, and may be almost said to enter the province of the expert; at any rate, the ability is only to be acquired by long and constant practice. It often happens that this condition does not obtain, because of the fear of having the metal freeze before pouring is completed.

It is customary with both the methods (A) and (B) after the metal has set, and while still hot, to quench it in water or weak acid; in water to remove the slag (B), and in weak acid to clean the surface before scrubbing. The centre of the bar is the last to set, and after setting a further contraction takes place until the bar is comparatively cool. Hence a cavity is formed in the centre due to the rigidity of the rapidly cooled sides. As this cavity forms, a partial vacuum is set up, which draws a filling into it through the centre of the top of the bar, that is, the line of least resistance; in case of method (A) of water, and of method (B) of slag with sometimes a little water. Usually the aperture connecting with the cavity is a small one, either a fine crack or a pinhole.

In the case of method (A), the cavity is filled with water or weak acid. Differences between local and home weights, before melting, vary considerably, since in some bars the apertures are so small that evaporation on the voyage to England is incomplete, and also some bars are subjected to more or less heat to dry the surface before weighing. If the bars poured by method (A) are thoroughly dried, no differences between local and before-melting London weights should occur. When they do, they are due to weighing and clerical errors. Owing to the lengthy war period, during which account sales have not been received, precise information of differences is not available. For many years it has been the author's practice, when the bar has been cleaned, to place it on the hot cover of the smelting furnace for about twenty minutes. Within fifteen minutes, if the cover is hot enough, the contained water is expelled with some force in jets of water or steam through the small apertures of entrance, and only when steam ceases to issue from these holes is the bar considered dry for weighing. On two occasions it was possible, with cold bars, by injecting air with a blow-pipe, to release the contained water, which amounted in one case to 10 cc. and in the other to 15 cc.

Under method (B), for some time after the bar has set and while it is still contracting the slag cover remains in a molten state, and is thus easily drawn into the cavity. If the bar is quenched in water to remove the slag while still very hot, a little water is often drawn in as well, and completes the filling of the cavity. Of 230 consecutive bars poured by this method 39 only showed a loss on reaching London, and the average difference between local and before-melting London weights was only 0·037 oz., or 0·74 dwt. This loss, the author suggests, was due to evaporation of the water filling during the voyage, that is, the water which entered the cavity after the slag had been removed from the bar. The slag which had already partly filled the cavity of course remained unchanged during transport.

Weights after melting are, of course, considerably less than those before melting, and it is sometimes assumed that this loss is solely due to the refining by oxidation during the remelt; doubtless there is some such loss, but that it accounts for the total difference is open to serious question. For example: of 22 consecutive bars poured by method (B) the average difference between the fineness estimated by assay at the mine, and that estimated by the buyers, was 0·07 milliemes, the buyer's assay being the higher. This difference on the 22 bars amounted to 1·5 oz. in favour of the sellers. The fine gold allowed for by the buyers was, however, 16·5 oz. less than the mine estimation owing to the loss of weight in remelting, nearly all of which may be fairly assumed to have been due to encased slag. Dip samples being taken in London, for assay, the increased value of 0·07 milliemes in the London assays most likely represented the amount due to refining during the remelt, which in the case of the 22 bars under consideration amounted to a total loss of weight of 1·5 oz. In support of this may be presented the fact that the weight of slag sufficient to displace 10 cc. of water is approximately 0·76 oz., and as above stated it was found possible to release 10 and 15 cc. from 2 bars respectively.

A discrepancy must occur between home weights and those of Johannesburg due to the difference in density of the air displaced by the brass weights used. Brass approximately occupies weight for weight twice as much space as gold, and the difference in density of this displaced air when weighing a bar of 1,000 oz. is equivalent to 7½ grains, which amount should be added to the home weight. The addition of this discrepancy would have brought the average deficiency on the 22 bars noted to approximately 0·77 oz.

From the foregoing the author is led to the conclusion that only an apparent discrepancy exists between the values of the gold estimated at the mine and those received from the buyers.

In the discussion which followed the reading of the paper, H. J. Brown, of Johnson, Matthey & Co., said there was a certain loss in melting due to volatilization, especially with base bars. With regard to the author's recommendation to pour gold at as low a temperature as possible, he said London practice with base bars was to use a fairly high, but not too high, temperature, and to stir thoroughly. R. R. Kahan, of the Australian Mint, agreed with Mr. Brown that it was inadvisable to pour too cold.

Hampton Plains, W.A.—The *Industrial Australian and Mining Standard* for December 18 publishes an article, by C. Sydney Honman, on the conditions and prospects of mining at Hampton Plains, West Australia. Last month we quoted a statement by Mr. Honman relating to the geology of the district, and we then mentioned that he was formerly an Assistant Government Geologist, and has recently examined the properties of the Celebration company. We quote his article in full herewith.

The new finds on the Hampton Plains, of which the most important are the Celebration and the White Hope (Slavin's), are situated respectively on Block 50 of the Hampton Properties, Ltd., and Block 48 of the Hampton Uruguay, Ltd., and give rise to the hope that they are the forerunners to a great revival of the mining industry in Western Australia. The nature of the ore deposits, and the geological conditions surrounding them, indicate that there are possibilities of other payable lodes being discovered. There is a well-defined belt of country which is practically unprospected, as far as lodes are concerned, and extends for a distance of 22 miles from the south shores of Hannan's Lake to Red Hill at Lake Lefroy. This does not include six miles of the belt which is buried under Hannan's Lake.

Geographically the Celebration is, as the crow flies, 19 miles S.S.E. of the Kalgoorlie post-office, and the White Hope is 5½ miles south-east by east from the Celebration. Feysville, a mining camp of the early days, is about three miles north of the Celebration, and on the same belt of country. Between Feysville and Red Hill, which is about 20 miles south-south-east of the former, a considerable amount of capital was expended by the Hampton Plains company in the early days, but it was principally spent in developing the quartz reefs and porphyry stockwork deposits, which did not come up to expectations. The topography of the country reveals the fact that a distinct ridge of high ground, composed of clusters of hills more or less connected, extends from the south shore of Hannan's Lake through Blocks 50 and 48 to Red Hill. If the trend of this belt of hills were produced through Hannan's Lake it would pass through the high ground of the Golden Mile. To the east of the range of hills on the Hampton Plains is a long valley parallel to it and extending northward to the east of the Golden Mile. To the west there is not such a well-defined valley, but a belt of low flat country extends parallel to the range and to the west of Kalgoorlie, only broken by the prominent boss of greenstone at Mt. Hunt. The presence of Hannan's Lake right across the belt, below Kalgoorlie, seems to suggest a break in the continuity of the rocks of the Golden Mile southward; but when the well-supported theory of the migration of salt lakes, advanced by Mr. J. T. Jutson in Bulletin 61, Geological Survey of Western Australia, and the known habit of salt lakes to migrate through the hardest rocks, are taken into consideration, it will be seen that such a continuity of the belt is not inconsistent with the presence of Hannan's Lake across it. A geological survey of the country made by the author in 1913 has shown that a belt of similar rocks to those occurring at Kalgoorlie extends beyond Hannan's Lake, and coincides with the range of hills above described, extending down to Red Hill. This belt of rocks, which is composed of greenstones and porphyrites, intruded by serpentine, gabbros, dolerites, and porphyries, is about 6 miles wide at Kalgoorlie, and 7 miles at the Celebration. It is bounded on the west by the Binduli-Wongi porphyry series, and on the east by the sedimentary series that extends from immediately east of Kalgoorlie to Lake Lefroy, east of Red Hill. Further detailed work, recently undertaken for the Hampton Plains company, reveals the presence of a band of serpentine in the belt having the same strike as Gibson's Hannan's Lake serpentine, and on the same line as the serpentine of the north end of Kalgoorlie, and an outcrop north of Feysville. This practically proves that an indicator of serpentine runs through the belt from Kalgoorlie to Block 50. The serpentine, where found on the Hampton Plains, occupies the same relative position to the adjoining rocks as it does at Kalgoorlie, and, further, the Celebration mine occupies the same relative position to the serpentine as do the mines on the Golden Mile. By a further detailed survey of the serpentine, it follows, therefore, that a belt of lode-bearing country should be defined, passing through the new finds at the Celebration and the White Hope. The fact that the lodes occurring there are similar to the Kalgoorlie lodes, in all essential characteristics, gives great encouragement to the idea that the country in which they occur is on the continuation of the Kalgoorlie ore-channel. By such an ore-channel is meant a belt of country within the limits of which the conditions are favourable to the occurrence of payable lodes, not necessarily continuous with each other, but occurring as roughly parallel lodes en echelon. Apart from any geological or topographical considerations, the distribution of the gold which has been discovered in quartz reefs, porphyry, and alluvial diggings, from time to time, agrees very closely with the belt of country as above defined.

The country has been very thoroughly prospected on the surface for quartz reefs and alluvial, and the chances of finding new occurrences of such are not nearly as good as those of finding lodes, which have been very little looked for in the past. Prospecting for lodes is attended with great difficulty, owing to the paucity of surface indications. In the cases of both the Celebration and the White Hope there were no surface indications of the presence of the lode, and no visible gold in the outcrops loamed up to. At the Celebration loaming alone showed the approximate position of the source of the gold, which did not outcrop at the surface except in isolated places as a ferruginous quartzite. When loamed up the gold occurred in a decomposed schist, such as is extensively outcropping all over the country. The White Hope, on the other hand, occurs in a fresh quartz gabbro amphibolite, as determined by C. O. G. Larcombe, of the Kalgoorlie School of Mines, and shows sulphides within a few feet of the surface, though no sign of the presence of sulphides could be seen at the surface, nor any other indications of the presence of a lode, except a depression here and there along the strike, due to decomposition and leaching of the lode near the surface. The source of some of the gold from the old alluvial diggings on Blocks 50 and 48 has not been found, but the fact that gold does not travel far from its source in the eastern goldfields of Western Australia has been further illustrated in two very distinct cases on Block 48, namely, at Westhead's, where the prospector found a rich quartz vein right under the alluvial, and at the White Hope, where the new lode as it is opening up strikes right across the top of MacPherson's patch, which was one of the earliest worked alluvial diggings on the eastern goldfields, and from which several thousand ounces of gold were won. A great deal of surface prospecting was done on the Hampton Plains in the early days, but in a more or less haphazard and widespread way, and, from all accounts, very little loaming. Future prospecting should be carried out in a more systematic manner, and the capital should be expended in the direction of discovering further lodes in the actually proved ore-channel.

The geological conditions on this field certainly warrant the systematic search for new lodes, and there is no reason why those already discovered should not extend downward at least as deep as the Kalgoorlie mines are now being worked.

Geology of the Andes.—At the meeting of the Geological Society of London held on February 4, J. A. Douglas read a paper giving an account of his geological investigations of the Andes of Peru along a line from the port of Mollendo to the Inambari River. Though the author does not touch on ore deposits his paper will be of assistance to mining engineers and mining geologists.

The deflection of the Pacific coast-line of South America north of Arica toward the north-west brings to light a zone of ancient granite and gneiss comparable with the rocks of the coastal Cordillera of Chile These rocks are shown to be of alkaline type, and are contrasted with the calcic granodiorites forming the batholitic core of the Western Cordillera. The author suggests that their formation preceded the uplift of the folded chains. The Jurassic zone of Northern Chile has been almost entirely stripped from the underlying plutonic core, but its continuation has been proved at more than one locality, and in the inter-Andean region strongly-folded fossiliferous beds of Bajocian age are found beneath an unconformable Cretaceous series. The batholitic core is shown to the author to comprise at least three distinct phases of plutonic intrusion, represented by granodiorites, diorites, and adamellites. The volcanic cones of the Western Cordillera have given rise to an extensive series of lavas and tuffs comparable with the Mauri-River Series of Bolivia. Cretaceous limestones take the place of the red gypsiferous sandstones farther south, and are transgressive on to Devonian rocks. The latter contain abundant fossils of Lower Hamilton age. The post-Cretaceous line of dioritic intrusion, formerly described as running through Coro Coro and Comanche, once more appears on the line of section. The Permo-Carboniferous fauna of Bolivia has not been discovered in the district here described, but beds of similar lithological character are found overlying fossiliferous limestones assigned to the highest part of the Avonian sequence. The eastern flanks of the Cordillera are composed of a great thickness of barren shales, slates, phyllites, and mica-schists, the only fossils discovered being graptolites of Llanvirn age. The area is further characterized by a well-marked alkaline province of igneous rocks, comprising elæolite-syenite-porphyry and rocks closely related to laurvikite, ditroite, and durbachite. A comparison is made by the author with a section drawn through Northern Chile and Bolivia, from Arica to the Bolivian Yungas, and he also reconstructs the history of the Cordillera.

SHORT NOTICES

Aerial Ropeways.—The *Iron & Coal Trades Review* for January 30 describes and illustrates an aerial ropeway built for the Castner Kellner Alkali Co., at Weston Point, near Runcorn, by R. White & Sons, Widnes.

The Cement Gun.—The *Colliery Guardian* for February 6 describes the "cement gun," which is being introduced into this country by the Ingersoll-Rand Co. It is successfully used for protecting exposed surfaces of rock underground and preventing their weathering and disintegration.

Wire Ropes.—The *Colliery Guardian* for February 13 publishes a translation of an article in *Glückauf* on winding ropes and bending stresses.

Lighting in Mines.—At a meeting of the Illuminating Engineering Society held on February 24, Dr. T. L. Llewellyn read a paper on lighting conditions in mines, with special reference to the eyesight of miners.

Removing Dust. – In *Chemical and Metallurgical Engineering* for February 4, M. R. Hall describes the system adopted by the Arizona Copper Co. for removing dust from the crushing house, the object being the improvement in working conditions.

Wulfenite.—The *Journal* of the Franklin Institute for January contains a paper by J. P. Bonardi on the separation of wulfenite (molybdate of lead) from barytes gangue.

Cyanide Precipitate.—In the *Engineering and Mining Journal* for December 13, G. J. Young describes the method of smelting cyanide precipitate employed at the Tonopah silver-gold mines.

Fume Precipitation in Japan.—The *Engineering and Mining Journal* for December 13 gives particulars of the installation of Cottrell plant for precipitating fume at a number of copper and lead smelters in Japan.

Chloridizing Roasting.—In the *Mining and Scientific Press* for January 17, H. R. Layng discusses the reactions involved in the chloridizing roasting process, and recommends the use of the chloride of an alkaline earth instead of a chloride of an alkali.

Cyanogen Chloride.—At a meeting of the Midland section of the Society of Chemical Industry held in Birmingham last month, T. Slater Price and S. J. Green read a paper on the preparation of cyanogen chloride on a large scale. It will be remembered that this compound was not popular as a substitute for bromocyanogen in gold metallurgy, but there was a demand for it for war purposes.

Hydrogen.—In *Chemical and Metallurgical Engineering* for February 4, H. L. Barnitz writes on the electrolytic production of hydrogen. We see no reference to the Jenkins cell, described in the Magazine for June last year.

Lead-coated Iron.—The *Journal of Industrial and Engineering Chemistry* for February contains a paper by Charles Baskerville on the protection of iron surfaces by metallic lead and lead compounds.

Rolling Lead Sheets.—*Engineering* for February 13 describes an electrically-driven rolling plant for making lead sheets, erected at the works of Holman, Mitchell & Co., at St. Helens, by the Metropolitan Vickers Electrical Company.

Transvaal Iron Ore.—The *South African Journal of Industries* for December contains a paper by A. L. Hall and C. J. N. Jourdan describing the Buffelshoek iron ore deposit, in the Rustenburg district of the Transvaal.

Kent Coal.—In the *Colliery Guardian* for February 20, A. S. E. Ackermann describes the Chislet colliery in north-eastern Kent.

Tungsten in India.—At a meeting of the Newcastle section of the Society of Chemical Industry, held in February, J. Coggin Brown read a paper on the occurrence and mining of tungsten ores in Burma.

Wolfram Camp, Queensland.—In the *Queensland Government Mining Journal* for December, L. C. Ball begins an article on the geology of Wolfram Camp, Queensland. Some particulars of the mining enterprise in this district was given in the Magazine for October last.

Volcanic Activity in Alaska.—In *Nature* for February 5, J. W. Shipley gives an account of the fumarole activity at Katmai, south-east Alaska, following the eruption in 1912, with particulars of the gases and mud-flows.

Substitutes for Petrol.—At the February meeting of the Institution of Petroleum Technologists, Dr. W. R. Ormandy discussed proposals for the use of mixed fuels containing members of the paraffin series with alcohol and allied compounds.

Conditions in Russia.—In the *Engineering and Mining Journal* for January 10, R. S. Botsford describes conditions in Russia.

RECENT PATENTS PUBLISHED.

☞ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.2., with a note of the number and year of the patent.*

18,974 of 1917 (112,275). L. P. BASSET, Paris. Improvement in the use of finely powdered carbon for reducing purposes in a blast-furnace.

10,797 of 1918 (117,264). SIEMENS-SCHUCKERTWERKE, Berlin. Improved machine for driving levels, etc., in mines.

12,887 of 1918 (128,906). I. BÖHN, Sorumsand, Norway. Improved driving mechanism for tunnelling machines.

16,335 of 1918 (138,137). E. F. MORRIS, Liverpool. Method of producing yellow antimony pigment.

20,095 of 1918 (135,942). R. F. SEWARD, Bournemouth. Reinforced-concrete supports for mines, etc.

20,208 of 1918 (122,170). AMERICAN ZINC, LEAD, & SMELTING CO., Boston. Method of preparing zinc oxide pigment in which the usual impurities such as lead, cadmium, and other zinc compounds are reduced to a form that will not be deleterious.

20,550 of 1918 (135,963). W. G. HAYWOOD, London. A bronze of high tensile and shear strength, consisting of 87% copper, 9% aluminium, with small proportions of titanium, iron, nickel, and manganese.

21,756 of 1918 (135,992). W. ACTON, Paisley. A continuous rotating suction filter.

1,732 of 1919 (137,609). H. W. MATHESON and F. T. KAELIN, Shawinigan Falls, Quebec. Electrolytic cell for oxidizing mercury.

2,566 of 1919 (137,626). H. G. HILLS and E. WHEELER, Manchester. Making iron oxide into briquettes by mixing with bituminous coal and then coking.

3464 of 1919 (137,930). G. GRÖNDAL, DJURSHOLM, Sweden. Method of leaching copper ores that have been subjected to a chloridizing roast.

4,641 and 6,696 of 1919 (137,657). J. D. EVANS, Swansea. Arrangement of removable bits for miners' picking and ripping tools.

6,999 of 1919 (138,211). J. B. EKELEY and W. B. STODDARD, Boulder, Colorado. Method of removing phosphorus and arsenic compounds in the production of a pure salt of tungstic acid.

9,460 of 1919 (138,228). A. G. MUMFORD, Colchester. An alloy of copper, tin, and zinc which will stand high steam pressures and temperatures.

9,903 of 1919 (136,076). J. M. BERGLUND, Ludvika, Sweden. An apparatus for sintering concentrates, distilling crushed shale, etc.

10,131 of 1919 (126,951). NORSK HYDRO-ELEKTRISK KVAELSTOFAKTIESELSKAB, Christiania, Norway. Converting carbonic acid to carbonic oxide by reaction with metallic sulphides, producing also oxides of the metals; then employing the carbonic oxide as reducing agent for the oxides.

10,755 of 1919 (126,303). C. L. LENOIR, Arreau, France. In producing manganese and its alloys in the electric furnace, means for preventing losses by volatilization and in slag.

NEW BOOKS

Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 723, Salisbury House, London Wall, E.C.2.

Tin Mining Handbook, 1920. By A. N. Jackman. Paper covers, pocket size, 252 pages. Price 5s. London: *The Financial Times*, 72, Coleman Street. Besides giving particulars of the many companies which are working, or are otherwise financially interested in, tin-mining properties at home and abroad, this book contains in convenient form useful statistical data relating to the production of the metal.

Quin's Metal Handbook and Statistics, 1920. By L. H. Quin. 320 pages, pocket size. Price 3s. 6d. net. London: The Metal Information Bureau, Ltd. This informative publication is well known in mining and industrial circles, and the new edition needs no further introduction.

Distribution of Ores of Tungsten and Tin in Burma. By J. Coggin Brown and A. M. Heron. Published by the Geological Survey of India.

COMPANY REPORTS

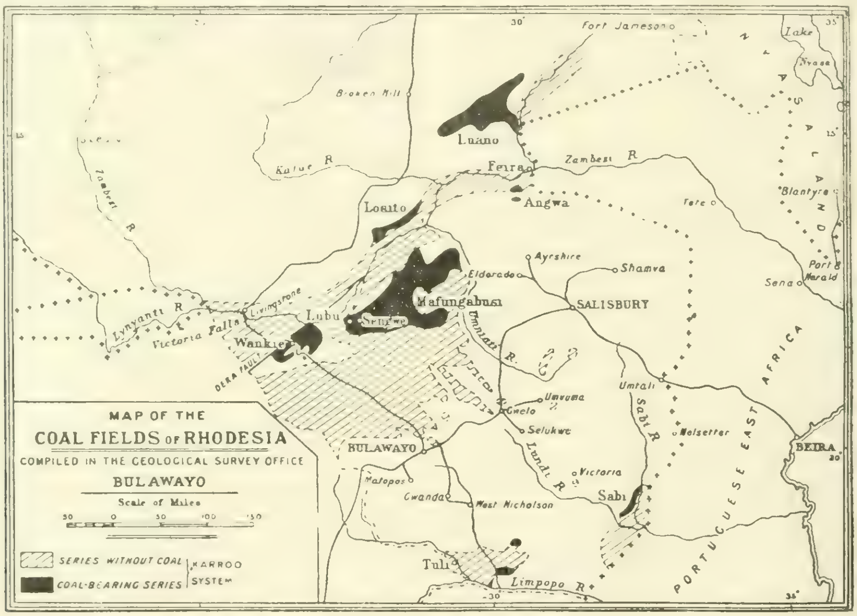
Tincroft Mines.—This company operates the Tincroft tin-arsenic-wolfram mine between Camborne and Redruth, Cornwall. James Wickett is the chairman W. Thomas is manager. The report for the year ended December 31, 1919, shows that in the first half 20,895 tons of ore was crushed for a yield of 170 tons 18 cwt. of black tin, which realized £21,792; and that in the second half 15,849 tons was crushed for a yield of 143 tons 12 cwt. of black tin, which realized £22,943. Arsenic brought in £13,624, and wolfram £4,620. Working costs totalled £80,385, and lord's royalties £1,747. The net outcome of the year's work was a loss of £15,885, of which the first half of the period was responsible for £12,461. In the two previous years profits were earned. The company commenced the current year with a debit balance of £13,107. The directors refer to the rise in tin to over £380 per ton, and state that at present the mine is making a small profit monthly.

Cordoba Copper.—The Cerro Muriano Mines, Limited, and North Cerro Muriano Copper Mines, Limited, were amalgamated in 1908 as the Cordoba Copper Company, Limited, and copper production was carried on at the property in Spain until April, 1919, when operations were suspended on account of the low average grade of the ore, and prospects in regard to cost of labour and materials, prices and supplies of fuel, rate of exchange, and the market for the metal. Subsequently a firm in Cordoba purchased for one million pesetas the whole of the company's property in Spain. During the period from January, 1919, to the date of the final suspension of operations, 10,995 tons of ore assaying 2·3% copper was raised from the mine, and 1,002 tons of ore of an average value of 6·73% copper was purchased from outside sources; 4,270 tons of ore and products from the concentrating and sintering plants was smelted, resulting in a return of 645 tons of matte, which was converted into 284 tons of blister copper. This realized £23,599. The revenue account for the twelve months ended December 31, 1919, shows a loss of £11,603. The balance sheet at same date shows a balance of assets (cash, Government securities, and debtors) over liabilities amounting to £73,772. These assets place the company in a position to pursue mining operations elsewhere, and the directors report that a working option has been secured over a copper-mining area situated in the Singhbhum district, Chota Nagpur, India, where some years ago the Cape Copper Company acquired prospecting rights over several miles of the copper belt and on the Rajdoha area of the belt has opened up what is known as the Rakha Hills mines, the only producers of copper in India. The free working option acquired by the Cordoba Copper Company covers an area of about 20 miles in extent, having a length of about 8 miles on the copper-bearing belt. On this area copper lodes have been proved to exist by means of bore-holes, adit levels, and shallow shafts, while ancient workings can be traced throughout the area along the outcrops of the several lodes. So far the chief discoveries have been made near the villages of Sirdar, Mosaboni, and Bodia, but pumps and winding engines are now required to enable these trial works to be efficiently carried on.

Le Roi No. 2.—Twenty years ago this company was formed to take over properties in the Rossland camp, British Columbia, and in 1908 it promoted the Van-Roi Mining Company to take over a silver-lead property it had optioned at Silverton. Le Roi No. 2 holds 63,193 ordinary and 10,483 preference shares of the Van-Roi, also 447 shares of the Dobbin and Cloncurry Mines (Queensland). The Rossland properties yield gold-silver-copper ore. The report for the year ended September 30, 1919, shows that 15,317 tons of ore was shipped in that period, and the gross value was \$264,576, or \$17·27 per ton. Smelting charges amounted to \$110,952, or \$7·24 per ton. The profit and loss account for the year disclosed a loss of £131, but £21,218 was brought in from the preceding year, so that a balance of £21,087 has been carried forward. The directors have declared an interim dividend of 1s. per share, less income tax. Alexander Hill & Stewart, the managers and consulting engineers, write that it is proposed to carry out vigorous development work in the northern ground from the existing levels of the Number One mine (which was the most important source of production during the past year) and to diamond-drill to depth before seeking facilities for pushing on deeper levels from the neighbouring property. The Number One vein being the westward dislocation of the War Eagle vein as displaced by the Josie dyke and fault, it is considered that the recent results in these workings, and the finding of the War Eagle vein east of the dyke, supply the guide to more effectively and conclusively test the prospects in depth for a recurrence of ore-bodies similar to those of the War Eagle vein itself in the Le Roi 2 neighbour's ground. It is also proposed to arrange for the resumption of deep development on the Annie-Black Bear boundary, which, it is stated, was suspended at a very interesting stage.

Oriental Consolidated.—Formed in the United States in 1897, this company leases from the Korean Government a gold-mining concession in the Unsan district. Dividend payments commenced in 1903. The report for the year ended June 30, 1919, shows an operating profit of 439,107 dollars (U.S. gold), and net receipts over all expenditures, after deductions for reserves, of 128,840 dollars. No dividend was paid for 1918-19, but one of 50 cents per share for the current financial year was declared in January. The five active mines in 1918-19 yielded 250,868 tons of ore at a mining cost of 1·98 dollars per ton, the value of the output being 5·84 dollars per ton. The quantity of ore milled was 52,804 tons less than in the previous year, one mill having been closed down at the beginning of the period under review. Operating costs were higher owing to the increased cost of labour, supplies, and motive power. The company has been constructing a hydro-electric power plant at Suribong; this was reported to be nearing completion at the end of July, 1919. The ore reserves at July 1, 1919, were estimated at 779,000 tons, containing $4,063,000. The general manager, Alf Welhaven, foreshadows much smaller construction expenses and reduced operating costs in the current financial year, and a mill tonnage "probably nearly the the same" as that for 1918-19.

Wankie Colliery.—The original company, formed in 1899 to acquire coal-mining rights in the Wankie district of Rhodesia, has been reorganized twice. Dividends were commenced in 1909-10 on the then issued capital of £202,616. The present capital is £600,000, and there are £58,000 first mortgage debentures outstanding. In the year ended August 31, 1919, a profit of £65,296 was earned, and dividends amounting to 10% (1s. per share), less income tax, have been declared for the period. The coal and coke sales for the twelve months amounted to 273,531 tons and 99,108 tons respectively. The coal reserves proved by development are estimated at 5,508,000 tons. The necessity of opening another colliery has been under discussion for some time. The value of that section of the coalfield north-west of the colliery is stated to have been proved by bore-holes and shafts. Three colliery sites have been surveyed, and the bore-holes sunk on one selected show the coal to be less than 200 ft. from the surface; consequently drifts can be used to work the coal seam, and a considerable saving in surface equipment will be thereby effected.



Tongkah Harbour Tin Dredging.—The company (which is managed from Hobart, Tasmania) has five dredges working off the harbour of Tongkah, on the western coast of Siam. In the twelve months ended September 30 last, 3,208,350 cubic yards of ground was dredged, for a yield of 1,149 tons of tin oxide, a reduction of 165 tons as compared with the previous year's return. The actual net profit was £75,548, against £118,920. Four dividends totalling 55% were paid, absorbing, with tax, £84,975. The directors regret that the high cost of both material and labour for building dredges has prevented their ordering another machine. The company has made arrangements with the Bang Tao Company to work their properties on a royalty basis.

Deebook Dredging.—This company was formed in Victoria in 1913 to acquire alluvial tin-bearing properties at the north end of Bangnon Valley, Renong, Siam. One dredge commenced work in August, 1914, and another twelve months later. One dredge has since been sold to a separate company called Ronpibon Extended (No Liability), formed in November, 1917, and Deebook holds 15,000 fully paid £1 shares, which stand in the books at £24,450, the cost of the dredge. Another concern, the Taiping Tin Dredging Co., Ltd., was formed in Penang in March, 1918, and took over from Deebook a dredge, machinery, plant, buildings, and workshop, the purchase price of £33,000 being payable in equal monthly instalments over 3 years, commencing March, 1920. With the proceeds the Deebook directors contemplate acquiring another property in the near future; failing that, the proceeds will be distributed to shareholders as a refund of capital. The profit and loss account of Deebook Dredging for the year ended May 31, 1919, shows that tin sales yielded £24,953, and a dividend paid by Ronpibon Extended brought in £3,500. The profit for the year was £10,913, and dividends totalling 4s. per share (£20,000) were paid during the period.

Exploration Co.—The report for 1919 of this company, which carries on a general financial business, and holds interests in a number of American mines, including Tomboy, El Oro, Buena Tierra, Greene-Cananea, and Chile Copper, shows a profit of £88,287, and a dividend of 15% (1s. 6d. per 10s. share) free of tax has been paid. There remained a balance of £98,138 to be carried forward to the present year, as against £66,101 brought into the 1919 accounts.

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CONTENTS.

EDITORIAL

THE attacks on Mr. H. L. Sulman continue in the American press. They are founded on misconceptions, and the statements made are only guesses. In our next issue we intend to publish a statement with regard to Mr. Sulman's position, which we hope will for ever put a stop to this unjust campaign.

FOR some time it has been known that low-grade cyanide, the calcium compound, is being made by the American Cyanamid Company, but details have hitherto been lacking. Particulars of this cyanide and its manufacture are given on another page, where the report by Mr. W. L. Landis is quoted.

IN making bibliographical references it is desirable that authors should not use the contraction *Min.Mag.* when quoting this Magazine. The contraction in question belongs by prior right to the *Mineralogical Magazine*, the organ of the Mineralogical Society. To avoid confusion it is recommended that the abbreviation of THE MINING MAGAZINE should be "*Mining Mag.*"

FURTHER cable messages from Dr. Chalmers Mitchell point to the demonstration of the practical usefulness of the aeroplane in reconnaissance work. During his voyage in the air across equatorial Africa he ascertained many characteristics of that unknown land. His conclusion is that much of the country is stale and full of corruption, and that it is awaiting the long delayed telluric change, when mountain and sea will exchange places and the face of the earth will be cleansed by the waters of the ocean.

A COMMITTEE has been appointed by the Ministry of Munitions to consider the present state of the law as regards the pollution of the air by smoke and noxious vapours. Experience in London of recent years is that the electric power and light stations, and also central heating installations, have been serious offenders in this direction. In both cases their champions have made much of the cleanliness of their methods ; nevertheless, they throw immense quantities of black smoke into the atmosphere, thus largely negativing the advantages otherwise accruing. The Commission might also investigate the reversion from gas to coal in kitchens, due to the wretchedly small portions of gas given by the slot machines.

READERS of the Magazine will notice that the name of the publishing firm is now given as "Mining Publications, Limited and Reduced." The addition of the last two words is necessitated by the cancellation of an outstanding liability of 10s. per £1 preference share. It has cost less to establish the Magazine than was originally expected, and there is no likelihood of the preference shareholders ever being asked to put up the rest of the money originally promised. The preference shareholders are men distinguished in the mining and metallurgical profession. We take this opportunity of thanking them for their invariably kind support.

THE governing body of the Imperial College of Science and Technology has issued an appeal for increased financial resources in order that the usefulness of the college may continue to expand. It is estimated that £600,000 is required for new buildings and equipment, and a further annual income of £100,000 is desired. The committee appointed by the governing body to conduct the appeal would do well to issue a statement giving details of the proposed extension, for the inclination to subscribe funds depends largely on the nature of their intended application. For instance, it is hardly appropriate to invite readers of this Magazine to subscribe unless the money is required for the Royal School of Mines; they would not be so interested if the funds are to be devoted to biology, electrical engineering, chemical technology, or astrophysics.

GYROSTATIC compasses are now being extensively adopted on shipboard instead of the magnetic compass. The reason prompting the change is, of course, the increasing difficulty of preventing interference with the magnetic needle by the steel in the structure of the ship and the employment of the electric current for power purposes, not to mention the old trouble caused by the continual variations of magnetic north. The question naturally arises whether this type of compass could not be used in mine surveys. In a mine also steel and electric currents give trouble, and the variations in the magnetic north introduce inaccuracies, as has recently been discussed in the pages of the Magazine. Mr. L. H. Cooke informs us that Professor Haussmann, of Aachen, has applied the gyrostatic compass to bore-hole surveying and also as an orientation instrument for the survey of deep workings, but with what degree of success is not yet known. It is not necessary here to discuss in detail the principle on which the gyrostatic compass is based or the method of construction, for full descriptions have recently been published in *Nature* and ***The Engineer***. Suffice it to say that a spinning wheel tends to seek the true north with a force proportional to the product of the rotation of the earth and the spin of the wheel. The faster the spin the greater the directive force. Three forms of the compass are at present in use, developed by S. G. Brown, Anschütz, and Sperry, in England, Germany, and America respectively. In the Brown compass the wheel is 4 in. in diameter, weighs $4\frac{1}{4}$ lb., and runs at 15,000 revolutions per minute. The maximum directive force of the earth on this wheel, when the spindle is pointing east and west, is equal to the weight of 30 grains with a leverage of 1 in. The force diminishes as the northerly position is reached, and with a deflection of 1° the force of restoration is only $\frac{1}{2}$ grain with a leverage of 1 in. It is clear, therefore, that very great care has to be exercised in the construction of the instrument. The various motions of the ship introduce many complications, and it is here that a mine compass would have a substantial advantage over a ship compass. In fact, the gyrostatic compass would be far easier to apply at a mine than at sea. The cost of the apparatus would be serious and would restrict its wide application, but it is probable that arrangements could be made in each mining district to establish a central body that would hire out the apparatus and the expert to use it.

DECIMAL coinage has not found favour with the Royal Commission appointed to consider the matter. In the first place, the Commission declines to interfere with the poor man's penny and shilling, and, in the second, it is pointed out that the supposed simplification of foreign transactions is illusory, for the variation in international exchange would continue to be the nuisance in this class of business. To us, the desirability of altering British coinage seemed to lie not so much in the immediate matter in hand, as in its influence in interesting the public in the metric system of weights and measures. The cause of decimal coinage has always suffered from the inability of the reformers to agree on a revised scheme; even the report of the Commission discloses this feature of the position. It is probable that nothing further will be heard of decimal coinage. The agitation for the metric system will, however, continue. Whether it will ever be officially introduced en bloc is open to doubt. It is much more likely to come gradually, following convenience in usage in particular cases. For instance, both gentleman and mechanic have learned to think in millimetres in the motor industry; this is a sign of the re-education which will steadily spread.

PRECISION in description is desirable when mining and metallurgical operations are the subjects of papers or articles, as, of course, on all other occasions. Grammatical and syntactical imperfections may be forgiven, for the editor ought to be able to put things straight. It is the incompleteness in technical matters that worries the editor, for he cannot supply the deficiencies. For instance, the February issue of *Mining and Metallurgy*, the new name of the Bulletin of the American Institute of Mining and Metallurgical Engineers, publishes a paper on the unwatering of a mine in Mexico by air-lift. The name of the mine is mentioned, but nothing is said of the nature of the ore. The quality of the water may have been affected by the ore and the decision as to the method of pumping may have been influenced by this factor. In any case it would be of interest to know whether gold, silver, copper, or lead was mined. In the same issue there is a paper on the coal-pulverizing plant at the Nevada Consolidated copper smelter. It is always advisable to say at once in the title of a paper whether the smelter is a reverberatory or a blast-furnace, and at present the problem of the application of coal-dust renders the distinction all the more necessary. Then again, last month we made reference under "Short Notices" to a paper on the method of treating cyanide precipitate at Tonopah. In the article quoted, the words "gold" and "silver" were not used once. Those who knew all about the subject did not require to be told what metal or metals were extracted, but the learner would be glad to have his way smoothed. The art of indicating the main features of any problem without offending the expert can easily be cultivated. For instance, the expert is satisfied if he is told that the output of the Rand during February was valued at three million pounds. No damage is done to him or to his informant if the words "of gold" are inserted after "the output." Thus the article on Nevada Consolidated might be entitled "Coal-Pulverizing Plant at the Nevada Consolidated Copper Reverberatory Furnaces," and that on Tonopah might have referred to "silver-gold precipitate" without any loss of professional dignity on the part of the authors. We are unable to give the missing information relating to the mine in Mexico that was unwatered, for the reference books, such as Weed's Mines Handbook, are equally cryptic. These omissions may appear to be of trifling importance to the expert, but to the learner and also to the teacher they constitute serious impediments to the easy spread of knowledge.

The Income Tax Report.

The report of the Royal Commission on Income Tax issued last month is, on the whole, an acceptable document, and shows a broad-mindedness characteristic of the chairman, Lord Colwyn. The expression "on the whole" refers particularly to the inclusion of proposals to modify or eliminate the powers of the independent Income Tax Commissioners. In many quarters vigorous protests have already been registered against any such interference with public rights of appeal against bureaucracy. With this exception it is fairly certain that the recommendations will find their way to the Statute Book. The proposed methods of personal assessment of income tax in such details as minimums for taxation, and allowances of various sorts, appear to remove all legitimate grievances with regard to unfair individual treatment. The scheme for preventing duplication of taxation within the Empire is also logical, though no doubt the decision not to grant relief in connection with double taxation as between Great Britain and foreign countries will perpetuate serious hardship in certain quarters. The speculators, amateur and professional, who have relied for an income on rises in market values of shares, have raised an outcry against the proposal to tax "casual profits." It cannot be seriously pleaded that such profits should not be taxed; the only argument against the new imposition is that it could only be effectively enforced by an unpleasant system of espionage and inquisition. There can be no doubt that a large section of the financial fraternity and their followers are at present making their profits in this way, and so escape payment of income tax, but this cannot go on indefinitely on the same large scale. Another class of objection comes from the dislike of the lumping together of husband's and wife's incomes in assessing the rate of payment. It is a distinct disadvantage to a wife who has an independence that her income shall be taxed at the higher rate, but, after all, she has the compensating advantage over the spinster of having a husband with an income. Some critics have said that this "penalizing" of marriage constitutes an inducement to concubinage. We don't believe it. After all, marriage is one of man's and woman's most valuable assets, and no reasonable being is likely to throw away the great advantages it affords in order to save a trumpery penny on the income tax. "On the whole," the principles involved in the Commission's report will, as we have said, receive general approval.

It is not, however, the broad question of policy that requires the special attention of mining men and investors in mines. The section appealing to them the most is that relating to wasting assets. It will be remembered that the Institution of Mining and Metallury, together with many other societies and committees, conducted an active campaign in pressing for greater allowance for amortization of capital, and that much expert evidence to this end was given before the Commission. The result of the campaign has been that the mining industry wins on some points and loses on others. But though the defeats may cause disappointment and irritation here and there, the new proposals can by no stretch of picturesque language be called iniquitous. From the point of view of the Commission the question turned not so much on the definition of the term "wasting assets" as on the nature of assets in mining. Briefly, it is held that an ore deposit is not an asset measurable in money at a capital value for the purposes of amortization. As far as deposits in this country are concerned the only amortization allowed would be that of the cost of the lease. On the other hand the Commission concedes that capital spent on shaft-sinking and initial development should be redeemable out of income without taxation. When a mining property is acquired by a British company situated in a country outside the influence of British income tax the case is different, and the Commission agrees that the amount paid as purchase price should be redeemable without taxation. But the amount allowed is not the capitalization of the property value as shown in the flotation of the company, but the first payment made to the actual owner of the property. This proposal is reasonable and acceptable.

The Commission's report contains an interesting disquisition on the general subject of wasting assets. It is held that all assets are wasting in degree. This no doubt is correct, but the argument would be clearer if greater distinction were made between the various causes of waste, or, more correctly, between waste and depreciation. As an instance, a mine may fail to yield profits either from exhaustion of ore reserves or from inefficient control and management. The report proceeds to say that no one ever contemplates an amortization of capital until the property comes within 35 years of its end. All mines can be, in their early days, presumed to have a less prospective life than 35 years, so will be allowed to start deductions for redemption from the beginning.

As regards the method of calculating the allowance of wastage of capital, the Commission recommends that the allowance shall be the sinking-fund payment necessary to amortize the capital over its agreed life less that sinking-fund payment necessary to amortize the capital if the life were 35 years. As to the rate of interest on which the calculation should be made, the Commission recommends $3\frac{1}{2}\%$, which is assumed to be the minimum rate of interest, after deduction of income tax, that a prudent investor will receive by investing his sinking fund in trustee securities. An example of the working of this method of calculation may be given. If the wasting asset is £10,000, and the life of the property 20 years, the annual sinking funds to redeem in 35 and 20 years respectively will be £150 and £354, so that the annual allowance will be £204. In assessing the expected life, great difficulties will naturally be encountered in connection with mines. The Commission recommends that recomputations of the life shall be made from time to time at intervals required by the assessors, and that provision shall be made for the rectification of wrong estimates so that tax overcharged may be repaid and tax over-allowed may be recovered. At first sight this proposal would appear to foreshadow the creation of an indefinite number of bureaucratic inspectors. If the question is examined closely, however, it becomes clear that as a rule the estimate of the life of the mine prepared by the engineer and approved by the directors will suffice, for those responsible would obviously not want to fix the estimated life at too low a figure. Moreover the results of any errors in computation or expectation could always be rectified in the subsequent event.

Our review of the Commission's proposals is necessarily brief. The report is voluminous, and though all the members signed it, several of them have done so with specified reservations. Fortunately it is well written, and thus the recommendations are easily followed. It is to be hoped that the draftsmen who prepare the Act which will be founded on it will take lessons in the art of perspicuous representation from the writer of the report. Before leaving the subject it must be added that this Commission was in no way concerned with the incidence of Excess Profits Duty. As a matter of fact the position of a mine as regards taxation requires consideration from the point of view of this duty as well as that of income tax. The Commission might to advantage be re-elected for the purpose of considering this bugbear of the business man, that is, of course, if this impost is to be continued.

Tin and Tungsten in Depth.

In this issue the Mining Digest contains the précis of three papers on tin and tungsten deposits in Burma and adjoining countries. One of these is by Mr. J. Coggin Brown, a member of the Indian Geological Survey, intimately associated with Burma, another is by Dr. W. R. Jones, who has spent several years in Burma, the Malay Peninsula, and China, while a third gives information relating to deposits worked by the French in Tonkin. Dr. Jones read his paper before the Institution of Mining and Metallurgy last month, and in it he elaborates his theory which was published in the Magazine for June, 1918. He presents evidence to show that tungsten minerals were deposited at lower temperatures than cassiterite, and that they are found in the upper parts of lodes and in the quartz and pegmatoid off-shoots from the granite, while the tin is found at deeper points, particularly in the lodes within the granite. In this Dr. Jones agrees with the late Mr. J. H. Collins and with Dr. Malcolm Maclaren, who have recorded this sequence in Cornwall. He proceeds to develop the application of this theory to the tin and tungsten deposits in the East, and he argues that a tin zone will make its appearance below the wolfram zone in Burma. At the meeting there was a pleasant and interesting discussion, which centred, however, not so much on Burma ore deposits as on the general theory of high and low temperature minerals. Professors Cullis, Rastall, Watts, and Gregory spoke, and gave presentations of several general features relating to the genesis of ore deposits. The discussion would have been more informative and lively had Mr. Coggin Brown and Dr. J. Morrow Campbell been there. The latter, in the Magazine for February, 1919, controverted Dr. Jones' view that in the Burma mines tin was deposited before tungsten, and referred to large numbers of specimens in which cassiterite crystals are deposited on wolfram crystals. At the meeting Professors Watts and Gregory referred to the difficulty of making deductions from paragenetic studies in this direction, for reversal in the order of deposition is constantly introducing complications. It is probable, therefore, that both Dr. Jones and Dr. Morrow Campbell will seek other evidence than that provided by hand specimens.

There are a number of points in the paper and the discussion that require reference. In the first place the high and low temperature theory as regards Burma deposits is weakened by the fact that fluorine compounds are extremely rare. The theory assumes that tin and tungsten came up as fluorides, the tin compound having a much higher boiling point than that of tungsten. On the deposition of the metals as oxides, it would be natural to expect to find the fluorine associated with some other mineral. Thus in Burma the fluorine minerals leave the theory in the lurch. On general principles also the pneumatolytic theory is partly obscured by the fact that tin and tungsten are not deposited as SnO_2 and WO_3, but the minerals are composed of mixtures or chemical compounds with other oxides. The fluoride theory does not fully account for the presence of the iron and manganese oxides.

Another phase of the subject which requires some comment is Professor Cullis's method of presenting the generalized scheme of sequence of ore deposits. He dealt in his speech at some length with the primary zones in which the various minerals are likely to be found, pointing out that lead and zinc were higher than copper, copper than wolfram, and wolfram than tin. This rule is often found to be correct, and it forms a useful instrument for geological diagnosis. Nevertheless it is a dangerous rule if applied wrongly, or if it is accepted as an infallible basis on which to found a deduction. For instance, the rule takes no account of the influence of wall-rock or crushed rock in the body of the fissure on the precipitation of minerals from solution. Moreover, it is enunciated in such a way as to lead a casual student to infer that by sinking deep enough lead will change to copper and copper to tin. This interpretation erroneously presupposes that mineralizing solutions contain all the metals. While it is true that nearly all lodes contain the minerals of a great number of metals, the general experience has been that ore deposits of a particular metal do not change profitably into another ore in depth. Examples of change are provided by Anaconda which was a silver mine near surface and changed to a copper mine at depth, by many of the Cornish lodes which contain copper above and tin below, and by the Bawdwin mine which contains increasing amounts of copper below the lead and zinc. But these are the exception. Thus the rule in question would be dangerous in the hands of a city promoter, who would be able by its means to persuade shareholders to put up additional funds for the purpose of chasing a hypothetical rich tin deposit below an exhausted copper mine or a profitable copper deposit under a zinc mine. The rule also has a tendency to give a false impression as to the habitat of the various metals as regards depth. For instance it leads to the supposition that tin is essentially a deep-seated mineral, whereas, as a matter of fact, the richest and coarsest tin is usually found at or near the surface. Moreover, cassiterite is often associated with metals near the top of Dr. Cullis's list; rich tin and silver are characteristic of many Bolivian deposits; and cassiterite and blende are often found together, as for instance at St. Agnes, where both minerals are in the sediments overlying the granite. As we have already said, the rule is a useful instrument of diagnosis in the hands of a competent geologist, but as Captain Bunsby would have said: "The bearings of the observation lays in the application on it."

A third point in connection with the economic geology of tin and tungsten that has caused considerable discussion is the relative liability of wolfram and cassiterite to disappear by weathering. At one time it was supposed that wolfram was as resistant to atmospheric effects as cassiterite, and several eminent geologists have definitely said so. More recent investigation has, however, shown that wolfram is disintegrated and is caused to disappear by chemical and mechanical action. It is probable that the misapprehension of the earlier geologists arose from the fact that wolfram is obtained from alluvial deposits. Wolfram does not disintegrate with rapidity in the absence of acids and if the debris or dumps remain quiescent; but if sulphides are contained with the ore the acid arising from them will soon exert a leaching action, or if the debris is subjected to the action of running water the wolfram will be so pulverized as to expose it to still more rapid action of the acid or even the wolfram will be carried away by the water. The outcrops of wolfram lodes which carry sulphides are usually leached of tungsten, oxides of iron and manganese remaining. This fact may provide food for thought in connection with the carriage of tungsten and the formation of its primary and secondary ores, but we will hold over further consideration of this subject at present.

REVIEW OF MINING

Introductory. — The triumph of Bolshevism in Russia and Siberia was not unexpected, but is nevertheless having a depressing effect. The unsettled state of Germany gives rise to uneasiness, as does also the resumption of armed action undertaken by France for its own protection. In the metal markets, prices have slumped severely. The steadying of New York exchange has reduced the premium on gold, and in consequence many mines in South Africa and elsewhere are once more thinking anxiously about their margin of profit. The proposals of the Government to debase the silver coinage so as to bring the bullion value down to the face value will relieve the pressure of buying to some extent, but is not likely to have any great influence in the silver market.

Transvaal.—The Union Government has taken the unusual course of publishing an official opinion as to the geology of the Far East Rand. A warning has been issued which controverts the Bleloch theory as to the presence of two payable reefs in the southern, or Heidelberg, section of the basin. A year ago we quoted a local description of the Bleloch theory, which claims that both the Nigel reef, or Main Reef Leader, and a continuation of the Van Ryn reef would be found in the south and west of the basin. The Government mining engineer now definitely states that the Van Ryn reef is not found in the Heidelberg district, and that what Mr. Bleloch assumes is this reef is really part of the Kimberley series. This warning must not be taken as acting adversely toward the many drilling enterprises in the Heidelberg district, for those in control are already aware that one payable reef is all that they may expect to find.

A change is to be made in the method of conducting the business of the Transvaal Chamber of Mines. The work of the chairman has become so onerous that no one desires the honorary position. The position also requires the exercise of a good deal of impartiality, or shall we say aloofness from obvious self-interest. It has therefore been decided to make the presidency a paid office, and to appoint an outsider for a term of years. The choice has fallen on Mr. H. O. Buckle, a Johannesburg magistrate. Mr. Buckle has won a reputation as a fair-minded public man of considerable administrative and judicial ability. It may be objected that he knows little of mining, but, as labour and political questions will occupy his chief attention rather than the technicalities of science and engineering, this objection counts for little.

Knight Central is a mine that has been on the verge of bankruptcy for several years. In 1917 shaft-sinking was suspended, and development was thereafter practically confined to the solitary promising place, on the 18th level east of the East shaft. The results obtained were poor, and closing-down was contemplated at the end of 1918. Just at this time, however, prospects brightened again and work was continued. At present operations are carried on at a small profit owing to the increased receipts due to the gold premium, but the developments are once more poor and the end may come at any time.

An agitation has arisen in certain quarters for the reopening of the Bantjes mine. The circularizer attacks the directors for not taking advantage of the gold premium and mining the known ore reserves. The directors have replied that the reserves amount to 222,000 tons averaging 33s. 6d. per ton, and that a profit of £66,000 could be made by treating them, calculating on a basis of present costs and gold premium. It would, however, be necessary to spend £100,000 in unwatering and re-conditioning the mine. Moreover, developments are such that there is little likelihood of additional ore being found in continuation of the reserves. Thus the agitation for reopening is not founded on economic grounds.

When the directors of East Rand Proprietary Mines issued their report they took such a hopeful view of the future from the point of view of the gold premium that they recommended an extensive increase in development in depth, and the installation of additional pumps to cope with water. The profit for 1919 was £286,596, of which £194,613 was due to the premium on gold. The ore milled was 1,409,500 tons, the realized value of the yield 27s. 10d. per ton, and the working cost 23s. 6d. per ton. The reserve is estimated at 2,634,350 tons, averaging 6·3 dwt. We do not know what influence the loss for March will have on the policy of the board.

The ore reserve at Geduld on December 31 was estimated at 2,580,000 tons averaging 7·4 dwt. per ton as compared with 2,510,000 tons averaging 7·5 dwt. the year before.

At Modder Deep the ore reserve on December 31 was estimated at 3,775,000 tons averaging 9·1 dwt. as compared with 3,450,000 tons averaging 8·8 dwt. the year before.

An accident occurred at Block A shaft of the Randfontein Central early this month. Parts of the hanging wall fell at No. 10 level, and stripped the shaft to No. 19 level. The output will necessarily be reduced for three months.

The action brought by Randfontein Estates, now in the control of the Barnato group, against Sir Joseph B. Robinson in connection with the sale of this property, was commenced last month. The plaintiff company claims £451,600 in connection with certain profits, connected with the Waterval and Uitvalfontein Farms. Alternatively the company claims £500,000 damages.

The Rooiberg Minerals Development Co. announces that it has acquired an option on the Weynek farm adjoining its properties, and is commencing exploration of the tin deposits contained in it.

Diamonds.—A prospectus was advertised in London last month, inviting subscriptions to a company called Kalahari Diamonds, Ltd., which has been formed to acquire from Mr. W. E. Bleloch his rights in connection with certain farms in Postmasburg district, 120 miles west of Kimberley. This district was mentioned in these columns recently when record was made of the Makganyene discoveries. Mr. Bleloch has nothing to sell except his rights on land in the neighbourhood. It is not quite clear what these rights are, or what the prospects are of finding anything valuable.

Rhodesia.—The settlement of the claims of the British South Africa Company against the Crown for the costs of administration incurred before the assumption of authority by the Government has once more been postponed. The Crown has asked for a postponement in order that further inquiries shall be made in South Africa. The Commission has suspended its sittings in the meantime, and will not resume for six months.

The development reports from the Globe & Phœnix are disappointing. Nothing of value is being found in depth, and the limits of the ore-body are now well defined. Lateral prospecting in the upper levels has disclosed little of value, but Mr. D. P. McDonald advises that the work shall be continued.

The proposal to amalgamate the Giant, Enterprise, and London & Rhodesian Mining & Land Co., referred to in the Magazine for September last, was withdrawn. Last month a similar proposal, namely, to sell the assets of the Giant company to the London & Rhodesian, was brought before the shareholders. Since the exhaustion of its mine the Giant company's assets have consisted of cash and of shares in other companies. Some opposition arose from shareholders who objected to so much cash being handed over to the London & Rhodesian, but a poll disclosed that this opposition was weak and the directors' proposals were carried by a large majority.

Since he took over the position of consulting engineer to the Gold Fields Rhodesian Development Company, Mr. Cyril E. Parsons has had the unpleasant duty of announcing the exhaustion of more than one mine. It is pleasant, as a contrast, to read his latest development report of the Shamva mines. Curiously enough, at one time these ore deposits were believed to be going the same way, for in depth their extent is fairly well known. The policy of lateral exploration, however, has given most gratifying results. Mr. Parsons now calls attention to the continuance of the favourable extensions of the deposits both in length and width. For instance, in the main open-cut practically the whole of the south wall is worth working. The length is about 1,000 ft. and the depth 500 ft., while the width is not yet ascertained. On the north face the ore is worth working for a length of 400 ft. to a depth of 300 ft., but here again the width is not known. Elsewhere on the property there are indications that the ore extends much farther than is provided for in the estimates. The Shamva ore is of low grade and does not warrant extensive work in proving exact assay-values and limits of payability, but as Mr. Parsons is a cautious and plain-spoken engineer, it is safe to accept his generalizations with regard to the long life of the property. His actual words are that the Shamva is "still in its early youth."

West Africa.—The Ashanti Goldfields Corporation reports a shortage of firewood and an exhaustion of the supply of anthracite. The output is therefore restricted, and in the meantime opportunity has been taken to repair the main shaft. The latest news is that a new supply of anthracite has arrived, and that when the shaft repairs are completed, about the middle of this month, the output will become normal once more, provided sufficient natives return to work.

The development of the manganese property in West Africa, controlled by Fanti Consolidated, is still in abeyance owing to the uncertain attitude of the Inland Revenue Authorities with regard to the taxability of the profits accruing to the parent company if a new company with expanded capital is formed to acquire the deposits from the preliminary syndicate that was formed to develop them. The authorities hint at a desire to tax these profits at once, although the practice has hitherto been not to tax increase in capital value until the shares are finally sold.

Nigeria.—A company has been formed by Mr. Lees Field, called the Yarde Kerri Group Tin Mines, Ltd., for the purpose of acquiring from Mr. V. W. Boyle thirty-five tin properties covering 100 square miles in the Bauchi district. Mr. Gerard W. Williams has written a report, and he mentions that the granite outcrop from which one of the alluvial deposits has derived its tin is workable.

The Associated Nigerian Tin Mines reports a slight reduction in current output owing to labour being required for the installation of additional plant and machinery. When this work is finished it is expected that the monthly output of tin concentrate will be at least 75 tons.

Australasia.—At the Waihi gold mine a dispute arose among the workshop engineers, who went out on strike, though offered wages granted by the Arbitration Court. The Miners' Union took the opportunity of striking also, demanding increased wages and extra allowances for overtime. The manager and directors at first stood by the Arbitration Court, and operations ceased, but subsequently the men's terms had to be granted.

Reports are once more prevalent that the British Government is arranging with the Belgian Government to sell to the Belgian smelters large amounts of Broken Hill zinc concentrates. It will be remembered that the British Government undertook to buy this material at an early stage of the war when delivery to Germany was suspended. The material is still mostly undelivered, and the Government has hitherto been in a fix to know what to do with it.

The action for libel started by Messrs. Henry R. Merton & Co., Ltd., against Mr. W. M. Hughes, Prime Minister of Australia, has been withdrawn on Mr. Hughes stating that "in the speeches he had made, while attacking an organization which in his opinion was a danger to the country, he had not made any allegations about, or reflections upon, any of the directors or officers of the company, or indeed upon any individual." This is rather a tame ending to the Australian politico-metal fulminations.

India.—The report of the Mysore mine for 1919 does not disclose any new development in the position since the doubling of the capital in December last. The £310,000 asked for on that occasion has been subscribed. Particulars of the output for the year are recorded elsewhere in this issue. The reserve is estimated as 870,000 tons as against 910,000 tons the year before, but no figures are given for the average value per ton. As regards developments in depth, the only section yielding good results is Ribblesdale's, where a continuous run of ore has been developed on the 53rd level. At other places rich ore is found only sporadically in depth.

During 1919, the Ooregum company treated 154,050 tons of ore for a yield of 89,245 oz. of gold, and 16,840 tons of accumulated tailing for a yield of 1,189 oz. The gold was sold for £383,439, and the working profit was £134,477, out of which £32,000 was written off for depreciation and cost of shaft-sinking, £12,433 was paid as income tax, and £93,173 was distributed among shareholders. The rate of dividend was 32½% on the preference shares and 22½% on the ordinary shares. The tonnage and yield have been remarkably even for many years, but owing to increased costs the profits have declined slightly. As regards development, the deepest levels on Oakley's shoot are giving gratifying results, and the reserve has been increased during the year by 35,276 tons, now standing at 427,966 tons. The position at depth on Oakley's shoot is of considerable interest. Down to the 54th level the ore was consistently valuable, but from the 54th to the 57th level the lode was practically barren. At this lower level gold once more put in appearance, and the results have been good on the 58th, 59th, and 60th levels. The 61st level has only been driven 75 ft., but for the whole of this distance the ore averages 28 dwt. over 30 inches. The company has acquired prospecting licences over extensive mining areas in the State of Kharsawan, near Chota Nagpur, Bengal, and has also taken shares in the Indian Mines Development Syndicate, which is conducting prospecting operations in Burma.

Burma.—Rumour has it that the Burma Corporation, now registered in India, is to acquire the Swansea Vale zinc smelters and the Avonmouth works. Mr. Tilden Smith is the controller of these three enterprises. He acquired the Swansea Vale smelters from Aron Hirsch und Sohn shortly after the outbreak of war, and considerably extended them. Subsequently, with Government financial aid, he commenced a new zinc smelter at Avonmouth, near Bristol, but this has not yet been completed. Presumably, if the report is true, the Burma zinc concentrates are to be treated in

Wales as well as in India.

Malaya.—In a recent issue we mentioned that the Pengkalen company had secured a new tin property. In order to provide funds for a dredge, the directors are offering 80,000 preference shares of £1 each for subscription among shareholders.

The capital of F.M.S. Timah, Ltd., is being brought up to a higher figure in order that it shall more nearly represent the actual value of the assets. A new company is being formed with a capital of £90,000, as against £20,000, of which only £15,000 is issued, and the shares will be distributed pro rata. This rearrangement will simplify matters for the issue of additional capital when required. The company, under the control of Messrs. Bright & Galbraith, Ltd., has done well with alluvial tin properties, which have been sold to the Kamunting, Kampong Kamunting, and Chenderiang companies.

Cornwall.—Our Camborne correspondent deals with the labour question, which has caused so much anxiety during the last few weeks. The settlement shows that common sense has been exercised on both sides. Our correspondent also deals with the East Pool and Dolcoath reports.

The Calloose Tin Mines & Alluvials Company announces that "a new policy has been adopted for the future working of the properties, by which all labour in the first instance will be concentrated upon the alluvial deposits." It seems rather early in the life of a company to be thinking about a new policy. We note that the company made its second appearance at the Ticketing on March 22, but cut rather an absurd figure, seeing that only 3½ tons was sold out of 16 tons offered.

The African and Australian Company is issuing £80,000 new capital for the purpose of acquiring mines in Cornwall. One property is the Parka, at St. Columb, seven miles from Newquay, and the other consists of the Wheal Hampton, Rodney, Tregurtha Down, and Owen Vean mines, at St. Hilary.

United States.—For some time the Arizona Copper Company, the headquarters of which are in Edinburgh, has been considering an offer to sell its mines and smelter to an American copper group, the identity of which is not disclosed. The directors now in America cable that terms cannot be settled for some time, as further detailed examination of the properties is necessary from the point of view of metallurgical treatment.

Mexico.—A serious fire occurred at the El Bordo silver mine, which is worked by the Santa Gertrudis company. The death-roll was 77. The damage done was below the 305 metre level. From this level to the 415 the timber was completely burnt, and below the latter the burning was partial. Repairs will occupy two months.

The San Francisco Mines of Mexico, operating in Parral, is about to create 250,000 new shares of £1 each for the purpose of raising money to extend the plant and increase the development. The shares will be offered as opportunity arises. Operations were resumed in December last after stoppages due to the political position in Mexico. Messrs. Knox & Allen, the consulting engineers, report that it is advisable to increase the daily capacity from 100 to 500 tons. At present lead-silver concentrate, produced by Wood flotation plant, is being sold, together with oxide ore, and an experimental plant is being run for the production of zinc concentrate.

Roumania.—The Roumanian Consolidated Oilfields, Ltd., has won its petition against the British Government for compensation for the destruction of its property and wells. It will be remembered that the British Government instructed Sir John Norton Griffiths to destroy the wells and oil supplies at the time the Germans were advancing into Roumania. The object of this action was to prevent fuel falling into the hands of the enemy that would help them in their submarine campaign. Neither the company nor the Roumanian Government was a willing party to this policy, and it was clear therefore that the British Government was solely responsible for the compensation. We gave an account of Sir John's exploit in October, 1917.

Spain.—The Rio Tinto company made a net profit for 1919 of £1,179,920, out of which £831,250 has been distributed as dividend, being 5% on the preference shares and 40% on the ordinary shares. The ordinary dividend for 1918 was 50%, for 1917, 90%, and for 1916, 95%. No particulars are given nowadays relating to the output of copper and pyrites.

Colombia.—The Colombian Mining & Exploration Company, having formed the Colombian Oilfields, Ltd., to take care of its oil properties, has now floated off a group of silver mines at Marmato as the San Antonio Mining and Smelting Co., Ltd. A smelting furnace is to be shipped from London next month.

Spitsbergen.—The Northern Exploration Company is about to issue 100,000 new shares, according to the scheme approved by the shareholders recently. The money is required for exploration during the coming summer.

ELECTRICALLY-DRIVEN PUMPS

By WILLIAM LAWS.

The author gives an outline of the principles of electrically-driven pumps, particularly of the centrifugal type, a class of pump increasingly used in mining operations.

(Concluded from March issue, page 144).

PRIMING.—As has already been explained, where it is desired to place a centrifugal pump in a situation where it has to raise water from a lower level, some arrangement for priming the pump is necessary. This is the disadvantage of the centrifugal pump as compared with the displacement pump, but one that is quite easily overcome. In smaller size pumps a foot valve is generally provided. The pump can then be filled by hand through a filling plug on the top of the pump casing, the expelled air escaping through a vent cock. When all the air spaces have been filled with water, the pump is ready for starting up as soon as power is supplied. If steam is available, the pump may be charged by means of a steam syphon, or else the water may be drawn into the pump by connecting it with the vacuum chamber of a condenser. These methods do not require a foot valve. If no other means are available, the pump may be charged by hand by means of a vacuum pump. Once the pump is charged and successfully started, it will continue to pump provided that the head does not become too great, or air leak into the pump casing, or that "cavitation" does not occur. This may occur on either the suction or delivery side of the pump, and is caused by the steady flow of water being interrupted. This may occur on the suction side if the back pressure becomes too great owing to the suction lift being too high, or on the delivery side if the discharge is carried much beyond the normal delivery for which the pump was designed. This is usually accompanied by overload on the driving motor and unstable delivery of the pump.

Desirable adjuncts to turbine pumps are the non-return valve and the delivery valve. The non-return valve is intended to protect the pump from being damaged by water hammer. The delivery valve is particularly necessary with electric drive, because the delivery of the pump on starting up may then be throttled down to zero. The pump is primed and started up. The motor is then started up light. As it runs up to speed the torque is slightly increased owing to the impeller churning up the water. When the motor is up to speed, the delivery valve is gradually opened and the motor picks up its load until it is running on normal load conditions.

In case the electric supply should be interrupted from any cause and the motor should stop, it is desirable to have a slow-closing foot valve. This causes the column of water to be brought to rest with less shock than if an ordinary foot valve were employed.

METHODS OF DRIVING. — Centrifugal pumps may be driven by belt or rope or toothed gearing. Direct drive is, however, preferable, and this may be in the form of steam or water turbine, steam or internal combustion engine, or electric motor. Wherever feasible, however, the electric motor is the best adapted for mining requirements. It may be made by either direct or alternating current motor. The D.C. motor possesses the advantage of speed variation, but the A.C. motor has greater simplicity of manufacture and working.

The speed variation of the D.C. machine may be a valuable asset where the head against a pump is likely to vary. On the other hand the A.C. motor is free from commutator troubles, and is particularly suitable for coupling direct to a centrifugal pump, because the torque at starting up is comparatively low. Also if two pumps are to be connected in series they may be connected on opposite sides of the same motor.

An additional advantage of the electric motor in mining work is the possibility of the centralization of power. The power for the whole mine may be supplied from one station above ground. By this means long steam lines with all their attendant drawbacks may be dispensed with. Also the comparatively small size of pumps and motors renders their transport through shafts and adits and their erection in the pump chamber a comparatively simple matter.

The problem of pumping deep shafts may be solved in two ways. Several pumping sets may be erected at different levels, as in Fig. 8, or they may be combined in one chamber at the same level, as in Fig. 9 (see next page).

In the first case the delivery pipe of each is connected to the suction pipe of the next. As an example of a plant of this sort we may

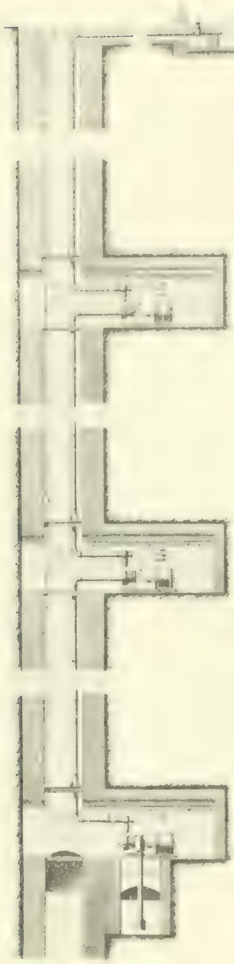


Fig. 8. Arrangement of several Pumping Sets at Different Levels.

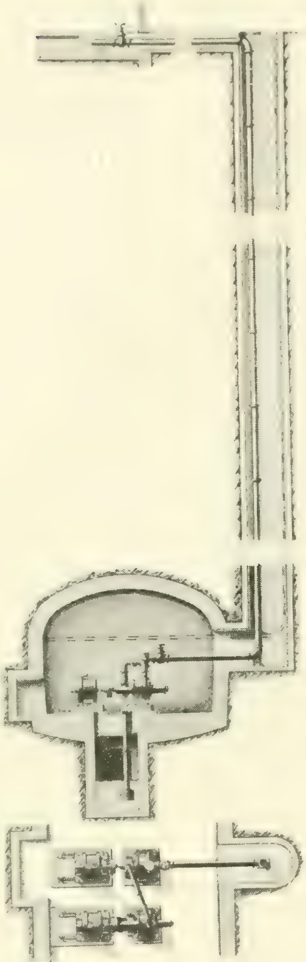


Fig. 9. Arrangement of several Pumping Sets in a Single Chamber.

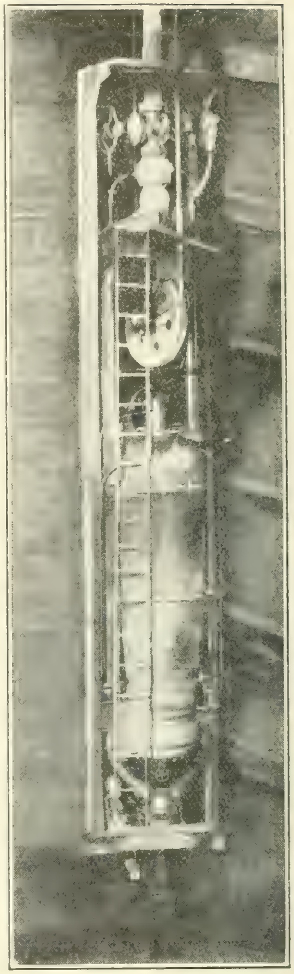


Fig. 10. Sinking Pump for Vertical Shaft.

quote that built by Messrs. Sulzer for the Compañia Minera y Metalurgica del Horcago in Spain and started to work in 1900. It consisted originally of three pumping sets for raising 925 gallons per minute to a height of 1,275 feet. Later, as the shaft was deepened, fourth and fifth pumping sets were erected, and the complete plant now discharges 1,142 gallons with a total lift of 1,970 ft. This plant works day and night without interruption, and the stoppages average 20 hours a month for clearing out the sump, cleaning the pumps and motors, and other work underground and in the power station.

In Fig. 9 we have an example of the other method, that is, a number of pumps connected in series at one level. It also was built by Messrs. Sulzer. It consists of two pumps connected in series and mounted in one chamber. It delivers 1,540 gallons per minute direct to the surface against a head of 1,719 ft.

Sinking Pumps.—Sinking pumps are used for sinking new shafts or pumping out old shafts which have become flooded from any cause. In the form of Fig. 10, manufactured by Messrs. Sulzer, the pump and electric motor are mounted together in one frame. We thus have one self-contained piece of machinery which can be readily raised or lowered in the shaft as the height of the sump water-level may require. The delivery pipe is fitted vertically in the centre line of the pump and supported by brackets or clips attached to the suspension ropes. Additional lengths of pipe can be attached to the discharge pipe as the sinking progresses. As this can be done very

FIG. 11. SINKING PUMP FOR INCLINED SHAFT AT THE LINDAL MOOR IRON MINES.

speedily, the working of the pump need not be interfered with for long, and there is no likelihood of the pump becoming submerged. Beyond being guided in the slide bars of the frame no other fixing is required, and as the movement of the moving parts is exclusively rotary and all parts are balanced, quiet working without shocks should be ensured.

Fig. 11 shows a pump by Messrs. Sulzer adapted for pumping in an inclined shaft with bearings specially adapted for inclined position. The frame is mounted on rollers. This pump is in the Lowfield Pit of the Lindal Moor Mines.

The motors to drive sinking pumps are generally of the totally enclosed type, water cooled, or of the protected type with drip-proof covers, to obviate damage that might be caused by dripping water. With electric drive the power transmission question becomes as simple as possible, and the conducting cables, which can be laid along the delivery pipe, occupy a minimum of space.

In mine work it frequently happens that it is necessary to pump water from two levels at the same time. To accomplish this an arrangement somewhat similar to that used in pumping deep shafts is employed. Two pumps are used. One deals with the water in the sump at the bottom of the shaft and discharges it into the second pump. This pump receives water from the higher level under pressure and discharges it together with the water from the first pump to the surface at the same time. A typical plant designed by Mather & Platt for this purpose consists of two high-lift turbine pumps working in series. The low-pressure pump has six stages and the high-pressure pump eight stages, and each delivers 800 gallons per minute against a total head of 1,500 ft. at a speed of 1,480 r.p.m. When working in series the combined duty is 800 gallons per minute against a head of 3,460 feet. Under this condition the motor, which is of the A.C. induction type, develops 1,450 B.H.P.

MAINTENANCE.—As in a centrifugal pump the only parts which come in contact are the shaft and bearings, the upkeep expenses should not be a serious matter, particularly as the clearance between the impeller and the pump-casing or guide vanes is usually greater than any reasonable wear in the bearings, so that the chances of there being any fouling of parts inside the pump are reduced to a minimum. Once the pump is installed, it requires very little attention beyond the usual attention given to any moving machinery, that is, ensuring satisfactory lubrication, attention to the glands, etc. A packing of fine cotton, served with tallow or graphite, is recommended. The glands should be drawn up just tight enough to prevent leakage, but not so tight as to produce excessive friction and thus reduce the efficiency of the pump. Sometimes pumps are designed with a connection from the discharge chamber to the glands, so that they are always primed or under a water seal. When this is so the glands should be rather looser than otherwise, in order to allow a constant slight leakage.

In course of time, after the pump has been working for some time, the inside of the casing, when of cast iron, as is generally the case, will become corroded by the water. This is owing to the high velocity of the water, necessitated by high head conditions, and will take place wherever water at high velocity impinges on cast iron, or wherever there is a sudden change of direction of the water causing shock. As a matter of fact it is frequently found that the efficiency of the pump increases after it has been in use for some time, owing to this very action.

When trouble is experienced with a centrifugal pump, it is generally due more to bad lay-out in the first place than to any fault in the pump itself, particularly if the pump has been installed by reputable makers. Bad arrangement of piping connections is a frequent source of trouble. Sometimes, owing to local conditions, these cannot altogether be avoided, but if the possibility of trouble in a particular direction can be foreseen in the first place, there will generally be a means of obviating it.

The following hints under this head may be useful, most of which are almost self-evident but are sometimes overlooked.

Suction Side.—In order to reduce suction lift a pump should always be installed as near the water as possible. The pipes should be as short and have as few bends and joints as possible, and also should be absolutely air-tight. This last is almost a *sine qua non.* Any leakage of air will reduce the vacuum and the possible suction lift and the quantity delivered, and will make the delivery-pipe pressure unstable. Should there be excessive air leakage on the suction side, the column of water will be broken, and it is possible that the pump will stop delivering altogether. The foregoing will of course not apply when the water flows into the pump under a head, but under such circumstances, should there be the possibility of any air pockets, it is advisable to have an air cock at the highest point of the pocket in order to allow any collected air to escape at intervals. When it is necessary to have bends in the suction pipe they should be of as big radius as possible, in order to avoid increasing the friction head, and also to avoid eddying.

The suction pipes should always keep inclining upwards towards the pump; failing this they may be horizontal, but at no point should they dip down. If they do, air pockets are sure to form at the highest point, and the pump will have very bad delivery. Cases have been known where an air pocket of this sort has been unavoidable, and it has been necessary to keep the point of the suction pipe at which the pocket formed in communication with the vacuum side of a condenser to eliminate the pocket.

On the suction side a foot valve and strainer are usually provided, the foot valve for use in priming.

Delivery Side.—From the very nature of a centrifugal pump it is necessary that the velocity of water in the pump itself should be greater than is usually allowed in piping connections. This being the case, the delivery pipe will generally have a greater bore than the delivery opening of the pump. To avoid shock this change in bore should be very gradual, and should be made by means of a taper pipe, specially designed for the particular pump. As mentioned before, a non-return valve on the delivery side is a useful adjunct, particularly when there is considerable pressure in the delivery main, as in the event of the power being shut off from any cause, it will prevent the pump casing being damaged by the back rush of water.

The monthly journal published by the Department of Mines and Industries of the Union of South Africa, called "*The South African Journal of Industries*," is not so well known in this country as it should be. We have on many occasions quoted articles on the mineral resources of South Africa, notably those written by Dr. Percy A. Wagner. In the latest issue to hand there is a report on the utilization of waste coal, presented by Professor G. H. Stanley and Dr. W. A. Caldecott to the Advisory Board of Industry and Science. This subject is attracting great attention in South Africa at present.

THE LEVANT DISASTER.

Report by H. A. ABBOTT, Inspector of Mines.

We publish herewith the official report on the accident at the Levant Mine last October, when 31 men were killed and 19 injured owing to the breakage of the man-engine.

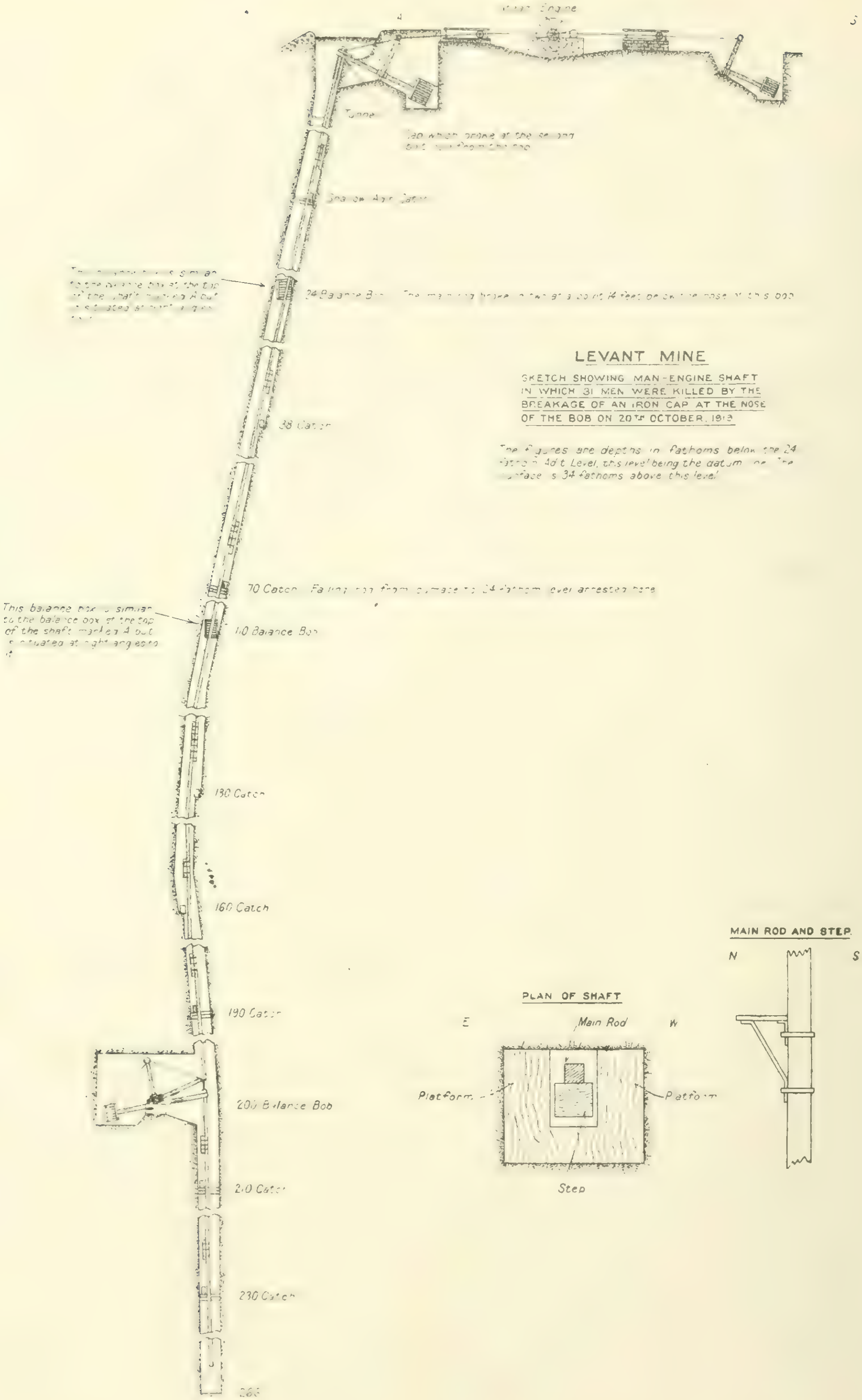
THIS accident which, in point of view of loss of life, constitutes one of the greatest disasters in the annals of mining in Cornwall, happened at about 3 p.m. on Monday, October 20. It was caused by the breaking of the man-engine, by which the persons employed below ground are raised from and lowered into the mine.

The Levant Mine is one of the oldest mines in Cornwall, and is situated on the cliff facing the Atlantic Ocean, in the parish of St. Just-in-Penwith, just over six miles north of Land's End, and about one and a half miles north of Cape Cornwall. It was established nearly one hundred years ago. I am indebted to Major Oats for the following description of the geological features of the mine. The mine is worked on two systems of lodes, the one system having a bearing of about W. 28° N. and underlying south about 20°, and the other system having a bearing of about N. 30° W. and an underlie of N. 20°. These lodes are in granite in the inland section, but pass into killas or shale before reaching the face of the cliff. The junction of the killas and granite is approximately parallel with the cliff, and at surface about 150 fathoms inland, but the junction dips toward the sea, and at the 278 fm. level is almost under the face of the cliff. Also almost parallel with the cliff in the killas is a greenstone dyke which can be traced from Gurnard's Head to the north, to the Longships Lighthouse off the Land's End, to the south, and at different depths in the mine. This greenstone dyke, which is of considerable width, is very hard and not congenial, the lodes in every instance being squeezed up and not very productive in passing through it. The lodes have now been worked to a depth of 350 fathoms and for a distance of rather over a mile under the sea, but the productive part is west of the greenstone, so that to obviate driving numerous levels through this non-productive part, the bottom of the mine is worked through land shafts which are down 278 fm. along a main 278 fm. level, and below this by means of an underground shaft, known as the Submarine shaft, situated about half a mile out under the sea and sunk from the 278 fm. level to the 350 fm. level. It is probable that the lodes were worked to a certain extent earlier, but there is no record until the mine was taken up by a local company which started work in 1820. This company, which was said to have started with a capital of £400, worked until 1871; during the first twenty years profits amounting to £170,000 were made and divided from the production of copper. There are several shafts sunk on the lode, one of which was equipped with a man-engine. It was the collapse of this engine that caused the deplorable accident which is the subject of this report. At the time of the accident this was the only man-engine in use in the county.

The manner in which the man-engine was introduced into Cornwall is described in Hunt's "British Mining," page 648, from which it will be seen that the first was put in at Tresavean mine in 1842, and the second one in the United Mines in 1845. It was not until 1857 that the man-engine at Levant was installed. This was put in at that time to a depth of 170 fm., and was actuated by a Cornish beam single-acting engine. The man-engine shaft was sunk further to the 230 fm. level, and the engine extended to that depth in 1888-89, while in 1897-98 it was sunk further to the present depth of 266 fathoms.

The original Cornish engine was replaced by the present compound tandem engine in March, 1893. In 1889 the present "dry," or changing-house, was brought into use, together with a tunnel connecting the dry with the man-engine shaft. This tunnel enabled men to get off the man-engine four fathoms below the surface, instead of at the surface, and to walk into the dry without exposing themselves to the weather after coming up from a hot mine. At the commencement of the shift a record of names of all men descending into the mine by the man-engine is made by a clerk stationed at the entrance to the tunnel through which the men must pass to the man-engine. When the man-engine was extended in depth to the 230 fm. level a new balance beam was put in at the 200 fm. level to help the three beams above to take up the extra weight.

The man-engine in its design and installation is very similar as regards the pit work to a Cornish pumping engine, and consists of an engine at the surface operating a quadrant or T bob, to the nose of which is attached a long


LEVANT MINE
SKETCH SHOWING MAN-ENGINE SHAFT IN WHICH 31 MEN WERE KILLED BY THE BREAKAGE OF AN IRON CAP AT THE NOSE OF THE BOB ON 20TH OCTOBER, 1919
70 Catch
110 Balance Bob
130 Catch
160 Catch
190 Catch
200 Balance Bob
210 Catch
230 Catch
PLAN OF SHAFT
E
Main Rod
W
Platform
Platform
Step
MAIN ROD AND STEP
N
S

pitch-pine rod 9 in. square, joined together in sections and traversing the length of the shaft. The rod is given a reciprocating motion by the engine in a slightly inclined axis up and down, the stroke of the rod being 12 ft.: but instead of it being used for raising water it is adapted for raising and lowering men, who stand one at a time on steps fixed at uniform intervals to the rod when the rod is moving in the direction they wish to go, or on platforms (sollars) fixed in the shaft when the rod is moving in the reverse direction, the distance apart of the steps and sollars being governed by the length of stroke of the rod. The platforms or sollars are so arranged that at the top and bottom of the stroke they coincide with the steps on the rod. In travelling the shaft, the men step alternately from step to sollar or sollar to step.

The rod in normal working makes five up and down strokes in a minute on this engine; therefore, men could be raised or lowered at the rate of 60 ft. per minute, the time occupied in ascending or descending 300 fm. being half an hour. The weight of the rod is to a large extent balanced by balance bobs attached to the rod; three of these were placed in the shaft at the 24 fm., 110 fm., and 200 fm. levels respectively, and two at the surface stated to be 20 tons weight, where nice adjustments can be made by putting on or taking off weight. It is arranged so that there is always an unbalanced weight of rod hanging on the quadrant at the surface in order to ensure the rod always being in tension and to obviate any tendency to buckling of the pitch-pine rods on the descending stroke.

The steam engine at the surface actuating the rod is a horizontal compound condensing engine of 5 ft. stroke, the high-pressure cylinder being 18 in. diameter, cutting off steam at $\frac{5}{8}$ths, and the low-pressure 30 in. diameter. The vacuum averaged 25 inches. The motion of the engine is communicated to the rod by a pinion wheel on the crank shaft having 14 teeth meshing into a spur wheel having 96 teeth. On the spur wheel is a crank pin to which is attached a connecting rod, which is also attached to the top of the quadrant. The stroke of the connecting rod is 12 ft. The engine usually ran with condenser in operation; but when no men were on the rod, and the condenser was cut out, the engine was just able to operate the rod with 30 lb. steam per square inch. It will thus be seen that the unbalanced load amounted to about 14 tons. When the shift of 150 men were on the rod their weight increased the unbalanced load to about 24 tons.

Provision is made to catch the rod in the event of it breaking. Eight catches (or "sills") composed of stout beams of pitch-pine are fixed in the shaft and eight catch pieces ("wings") are secutely fixed to the rod and so disposed throughout the length of the shaft that when the rod is at the bottom of its stroke there is a uniform space of small dimension between catches and wings.

The rod is attached to the quadrant beam at the surface by two strap plates 16 ft. 3 in. long, 6 in. wide, $1\frac{3}{4}$ in. thick (locally termed "caps"), bolted with 11 bolts to the rod. The caps extend through a space in the end of the beam, and are secured by a gib and cotter above a stout pin fixed in a pedestal on the beam. The rod terminates about 1 in. below the pin.

In the report of the Royal Commission on Metalliferous Mines and Quarries, which was issued on June 12, 1914, the Commissioners state:

"The old-fashioned man-engine by which men descended and ascended on platforms fixed to a moving rod, from which they stepped on to another series of small platforms at corresponding levels on the sides of the shaft, is still used in one or two cases, but we understand that it is regarded as a survival from the past, and those which are still working at the Levant Mine in Cornwall and at the Great Laxey Mine in the Isle of Man, are the only ones brought to our notice.

"The use of man-engines for raising or lowering men is, as we have already observed, almost obsolete. The following provisions on the subject are included in the special rules in force in the Cornish district:

78. In all future man-engines or additions to existing man-engines, whenever it is reasonably practicable, there shall be a fixed platform or sollar, not less than 2 ft. long by 2 ft. wide, on each side of the shaft, and immediately opposite each step of the man-engine, when it is at the top or the bottom of its stroke. Where a sollar in any existing man-engine is less than 2 ft. long and 2 ft. wide there shall be a handle or bar to hold on by while standing on it.

79. There shall be a height of 6 ft. 6 in. without any obstructions above each sollar, so that men shall not require to stoop when stepping on it.

80. Where there is any hole or trap-door at a sollar a handle or bar shall be provided to lay hold of.

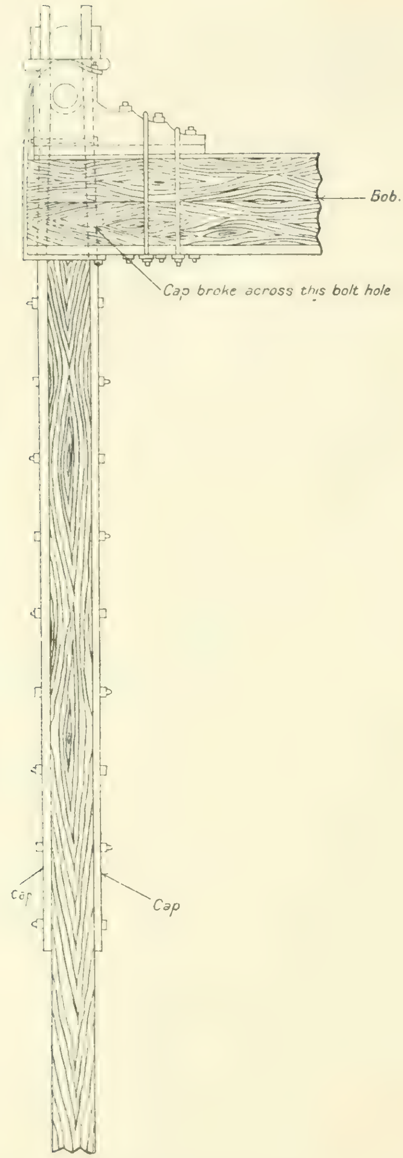
81. No person shall leave a trap-door open at any of the sollars.

82. There shall be easy means of signalling to the engine-man from every sollar.

83. No person shall signal to the engine-man, save in case of necessity.

84. Every fixed platform or sollar shall be provided with fend-off boards or funnel boards underneath, or a hinged board to lift.

85. A handle shall be fixed to the rod above each step, so that it can be conveniently grasped by a man or boy.



SIDE VIEW OF MAN-ENGINE ROD CONNECTED TO THE BOB, SHOWING THE FULL LENGTH OF THE CAPS.

86. Not more than one person shall ride on a step at one time.

87. No person shall be allowed to carry tools when riding, save for the purpose of repairing the man-engine or man-engine shaft, except the pitman and timberman.

88. A competent person shall be appointed to examine the man-engine frequently, and see that all the catches, steps, sollars, fend-off boards, trap-doors, fences, and handles are kept in a fit state of repair.

"We consider these provisions adequate and we understand that accidents are extremely rare. It is, in our opinion, hardly necessary to make any general regulations by statute regarding man-engines, but we think that the prohibition against carrying tools except for purposes of repair and inspection might be inserted in the Act, and that there should be a daily inspection of the machine and that a report of the inspection should be made in the same way as in the case of other means of ascending and descending the shaft."

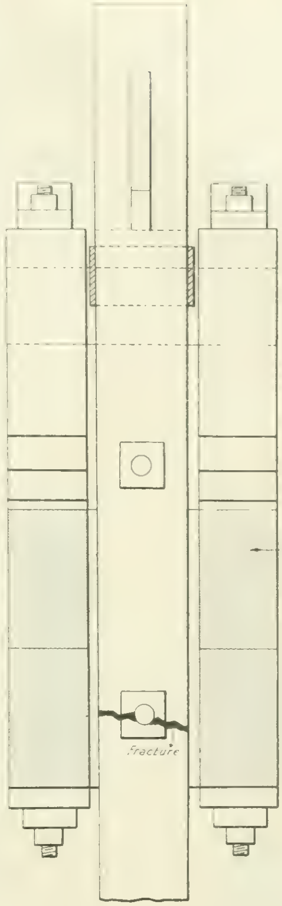
The accident occurred when the man-engine was almost fully loaded with men ascending from the mine. The breakage occurred on the upstroke when the man-engine rod was within 18 in. of the top of its stroke. Up to this time all the evidence points to the engine working smoothly and normally; nothing had occurred to cause the slightest alarm or indicate that anything was wrong.

Early in the rescue work a part of one of the caps was found on the first or top sollar, and this was brought to the surface and preserved. It was the top portion of the cap on the footwall side of the rod. It had been fractured at right angles to its long axis through the second bolt hole $29\frac{1}{4}$ in. below the cotter hole by which it was attached to the quadrant beam. It was at once apparent that there had been no elongation of the metal or reduction in area at the point of fracture due to strain. Careful examination of the fracture was made with a magnifying glass. It appeared short, and had several short faces and one long face about 2 in. square, extending from the interior to the outside, and the metal appeared darker than might have been expected in good iron; there was no discolouration visible such as might have been caused by a pre-existing crack, and it did not appear to be a case of long continued propagation and development of fracture. The presence of cold laps had probably caused some local accumulation of stress resulting eventually in rupture which, from the same cause, had rapidly extended across the section. There seemed to be signs of non-metallic inclusions.

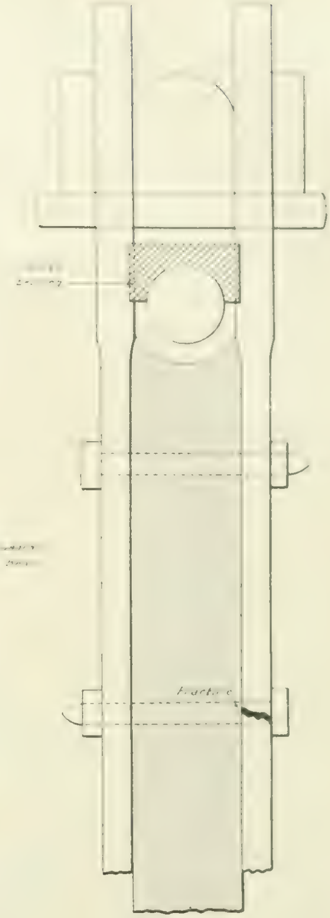
A piece of the whole cap, including the fracture, was cut off and sent by the company to the Sheffield Testing Works, Ltd., for examination, test, and report. The result of this test and the Testing Company's report are as follows:

"The sample was badly pitted and corroded, and was also very scaly in places on the surface, suggesting cold laps in forging. At the position marked G in the fracture, there is what appears to be a large cold lap. This extends from the surface and goes deeper into the section. The edges of the fracture have the appearance at some places as if the fracture had been assisted in its growth from similar small cold laps, and had gradually grown from all the laps in different directions, until the solid metal remaining in the section was not sufficient for the work it had to do and rupture took place. From the appearance of the fracture and the surface of the sample, we are of opinion that fracture has taken place on account of the method that has been adopted in forging the strapping plate. Wrought iron is produced by piling one piece on top of the other and then heating the lump to such a temperature that it can be forged or rolled, and a certain amount of slag is always left between the pieces that have been piled together. Under the best circumstances the piling in a sample of iron should be practically parallel to the surface of the sample; but the iron in the sample under construction has by some means or other been forged so that thin edges of the piling have come to the surface. This is a source of weakness in the iron on account of slag that may be between the piling, as the iron has a tendency to open out along the slag; and we are of opinion that this is the reason why the strapping plate has failed in use."

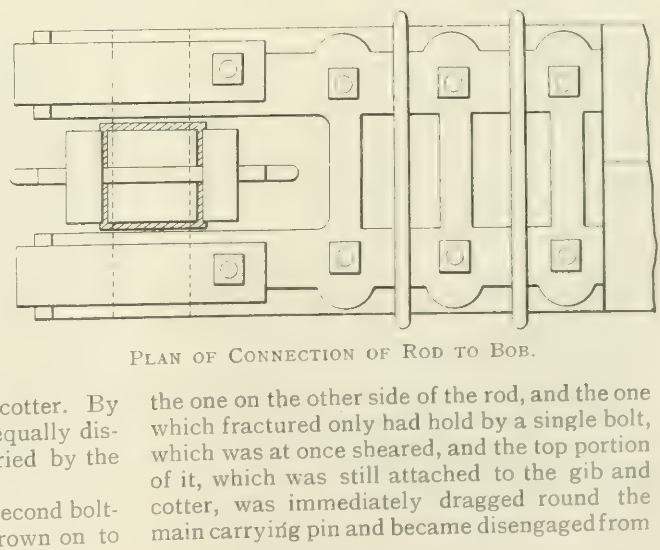
When one of the caps fractured, the rod was free to fall back on to the catches or sills. The reason of this will be seen by referring to the drawing showing an end elevation of the caps attached to the rod. The caps, which extended above the rod about two feet, were fixed on opposite sides of the rod by bolts passing through the rod and both caps. These extensions were placed one on each side of the main carrying pin on the end of the quadrant beam or bob, and attached thereto by a gib and cotter, which passed through a slot in each cap above the main carrying pin. A brass bearing with steel coverplate was interposed between the main carrying pin and the gib and cotter. By this means the whole of the load, equally distributed on the two caps, was carried by the gib and cotter.



FRONT VIEW OF BROKEN CAP.



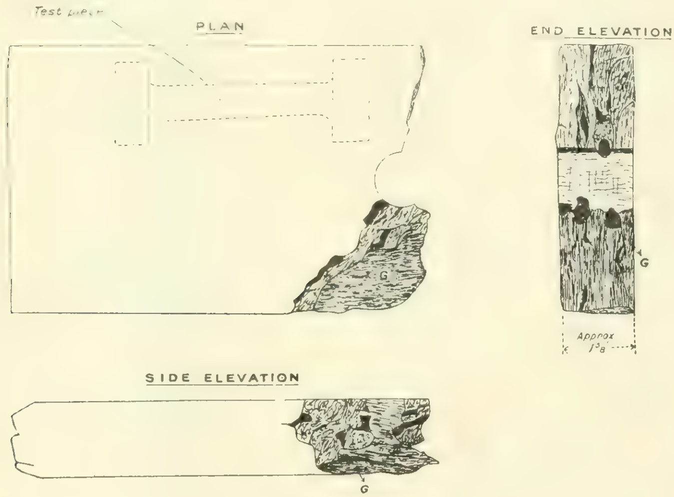
END VIEW.



PLAN OF CONNECTION OF ROD TO BOB.

As soon as the cap broke at the second bolthole, the whole of the load was thrown on to the one on the other side of the rod, and the one which fractured only had hold by a single bolt, which was at once sheared, and the top portion of it, which was still attached to the gib and cotter, was immediately dragged round the main carrying pin and became disengaged from the gib. This caused the hold of the cap, which did not break on the main carrying-pin, to be unbalanced and displaced, and the rod was then free to fall.

The rod fell with its load of men a distance of 10 ft. 6 in. to the catches. Unfortunately, owing probably to the swaying of the top portion which was now loose, the rod in falling got out of line, and this resulted in the wings only partly engaging the sills. The supporting timber fixed across the shaft carrying the top sill failed to hold; the second wing at the 38 fm. level only partly engaged the catch and sheared the front portion off, leaving no support for the wing; the 3rd, 4th, 5th, and 6th catches failed, but the 7th and 8th, at 210 fm. and 230 fm., held the rod, but were very severely compressed.



THE FRACTURED PART OF THE BROKEN CAP.

At the same moment the rod was also brought to rest by striking the floor at the bottom of the shaft.

Unfortunately, when the cap broke, the rod also broke at a point 60 fathoms below the cap, and the 60 fathoms of rod, carrying 30 men fell 46 fathoms to the 70 fm. level, destroying the platforms in its fall. To this occurrence may be ascribed the heavy death roll. Had this rod not broken, it is possible there might have been no fatalities to record.

The rod broke at a point 14 ft. below the 24 fm. balance-bob, and a few feet above the connection of the bob to the rod. The rod at this point was 9 in. square, and the fracture showed the wood to be of perfect quality; and its breaking can only be accounted for by the upper portion of the rod being free to sway on being released by the fracture of the cap near the quadrant at surface. When the rod struck the catches in falling it would be subjected to an impacted load, and it is probable that, owing to the swaying of the rod above the point of fracture, it may have been at the same instant subjected to a bending moment. It was strong enough to withstand the impacted load, but the combination of the two forces acting simultaneously upon it was the probable cause of its failure.

The bodies of the deceased were recovered from the following positions in the shaft: Just above the adit level (24 fathoms deep from the surface) 7, just below adit level 4, first step above 24 fm. level 1, first step below 24 fm. level 2, at 38 fm. level 2, above 60 fm. level 9, below 60 fm. level 3, at 70 fm. level 1, at 80 fm. level 1, at 110 fm. level 1. The last body was recovered on the morning of October 25.

The uninjured men who were in the shaft at the time of the accident were able to make their exit by the ladders in the shaft to the levels, and thence to surface by the ladders in the pumping shaft.

Examination of the shaft and engine after the accident revealed nothing that would indicate that the man-engine had been catching anything, and there was no evidence forthcoming from the men who were on the rod and others in the shaft at the time that such had been the case. Apart from the breakages caused by the falling rod the shaft was found to be in fair working order.

The result of the cap breaking was to release the balance weight at surface. This was about 20 tons. The unbalanced load was thus increased to 44 tons, and the energy developed by this weight falling 10 ft. 6 in. thus amounted to 462 foot-tons. Assuming that the eight catch beams absorbed this energy in a deflection of three inches, the force of impact on each would be 231 tons. The beams were strong enough to withstand this load, but the method of fastening them in the shaft failed in several of them.

As regards the strength of the caps, the material of which they were composed is said to have been faggotted iron; the load of 24 tons was distributed over two of them. The cross sectional area of both was 16·2 square inches, and the combined strength of them, as indicated by the Sheffield test, should have been 356 tons, giving a factor of safety of 15 to 1 compared with the ultimate strength, and of 10 to 1 as compared with the yield stress in the region of the elastic limit.

The sample tested by the Sheffield Testing Works shows that the material was of good quality, and judging from the test the designer had selected material which he had rightly assumed to possess the necessary strength and qualities for the stresses it had ordinarily to bear.

If it had been uniform in quality throughout it would not have broken, and the accident would not have occurred. Owing to the method of manufacture it was not uniformly good throughout: there was a defective part in it, and unfortunately this was near the top of the cap. If it had been at the other end of the cap, and provided the metal was otherwise equal in quality to the test piece, it is safe to conclude the accident would not have happened from this cause. The defect was internal, and a close inspection would not have revealed it. The cap was annealed three years ago, and the engineer failed to discover anything wrong with it after a close inspection made when it was hot.

THE PROPERTIES OF TEHIDY MINERALS, LTD.

Particulars are here given of the mineral properties controlled by Tehidy Minerals, Ltd., acquired from the Tehidy and Lanhydrock estates.

IN the Magazine for July, 1919, an article accompanied by a map was published describing the properties in the Basset, or Tehidy, estate in the neighbourhood of Camborne and Redruth, the mineral rights of which had been acquired by Tehidy Minerals, Ltd. In the September issue an account of the acquirement of mineral rights on Lord Clifden's, commonly called the Lanhydrock estate, was published. At the time it was not possible to give a map owing to the complexity of detail and the incompleteness of the schedule of properties. A statement was issued by the company last month on the subject, and on this the following brief description has been founded.

In 1918 the Dolcoath Mine, Ltd., and East Pool & Agar, Ltd., purchased the whole of the mineral rights of the Tehidy estate in the Camborne and Redruth area and adjoining parishes, and in February, 1919, these rights, with the exception of the Dolcoath and East Pool properties, were sold to a company incorporated under the title "Tehidy Minerals, Ltd." The properties sold consisted of the mining rights over about 8,000 acres, together with damaged lands and water rights as follows:

(A). The mineral rights of the main part of South Crofty mine now under grant to South Crofty, Ltd., which company also holds the lease of New Cooks Kitchen and the licence of North Crofty and Trevenson.

(B). The whole of the tin stream works on the estate, which are held under 26 leases.

(C). The mineral rights in the mines now idle, namely: West Seton, Violet Seton, South Seton, New Seton, East Wheal Seton, Wheal Emily Henrietta, Great North Seton, West Roskear, Wheal Francis, Basset, South Basset, North Basset, South Carn Brea, Crane Mine, Wheal Wellington.

(D). Large tracts of unprospected land formerly held by the Tehidy estate in Camborne and Illogan, comprising an area of about 6,000 acres, together with any mineral rights of the Tehidy estate in the adjoining parishes.

(E). Certain undivided mining rights in several mining setts.

Within this area, which extends in a continuous line of over five miles, it is believed that profitable lodes of ore may be developed, having regard to the fact that this mining district is probably the most highly mineralized zone in England. A large proportion of this area has remained not only unworked but unprospected, as the successive owners of the estate have always refused to allow mining operations to encroach on the home and adjacent farm lands, or even to come within sight of the Tehidy Mansion.

The company thereby became possessed of what is probably the biggest tin area ever dealt with by one organization, with correspondingly favourable facilities for exploratory work.

In August of last year it was announced that the company had acquired the mineral rights of Viscount Clifden's estate of some 25,000 acres in practically all the chief china-clay and mining areas of the county, thus securing a more powerful grip of certain important tin and other mineral areas, including those adjacent to and closely associated with the Basset properties, in addition to the extensive china-clay interests in the Bodmin, St. Austell, and other districts. The interests thus acquired cover the mining rights over very large areas, and include the whole or part interest in the following:

(*A*). Tin mines: Tincroft, North Pool, West Tolgus, Wheal Agar, South Crofty, two North Setons, East Wheal Agar, all in the Camborne-Redruth area; Alfred Consols, Great Wheal Alfred, Relistian Consols, Herland, Retallack, Halmanning, Unity Copper, Wheal Prosper, between Gwinear and St. Hilary; Ding Dong, north of Penzance; parts of Boscean and Boswidden, at St. Just; and a large block in Wendron.

(*B*). Silver-lead mining areas, including Wheal Jane and Deviock Wood, near Cardinham; and Pentireglaze, between Pentire Point and Port Isaac.

(*C*). Iron deposits; very considerable quantities of hematite iron of excellent quality in Roche, Lanivet, and Withiel parishes.

(*D*). Quarries; there are several granite quarries, eight under grant, and upwards of 20 stone quarries of considerable potential value, particularly in view of the extensive projects under consideration for buildings and road construction.

(*E*). Tin streams, water rights, and valuable easements.

(*F*). China-clay areas. The following is a list of the china-clay areas within the property of Tehidy Minerals, Ltd.

(1). Rowden and Newton, adjoining the North Cornwall pits on Stannon Marsh.

(2). Temple district, including (*a*) Merrifield; (*b*) Dewey Marsh; (*c*) Dewey Meads; (*d*) Menridden East; (*e*) Gillhouse; (*f*) Hulker and Carboulf (Northwood); (*g*) Gazeland Extension, etc.

(3). St. Austell district, including the following properties under lease: Carpalla, Halviggan, North Halviggan, Blackpool, Ruddle Common and Ennis Vath, South Nine Stones and Treskilling Downs.

(4). Porkellis Moor, near Wendron. In this area Tehidy Minerals owns half mineral rights.

(5). Ding Dong district, in the Land's End granite.

(*G*). Freehold Land. Fairly large areas of damaged lands and the freehold of two farms of (about) 250 acres.

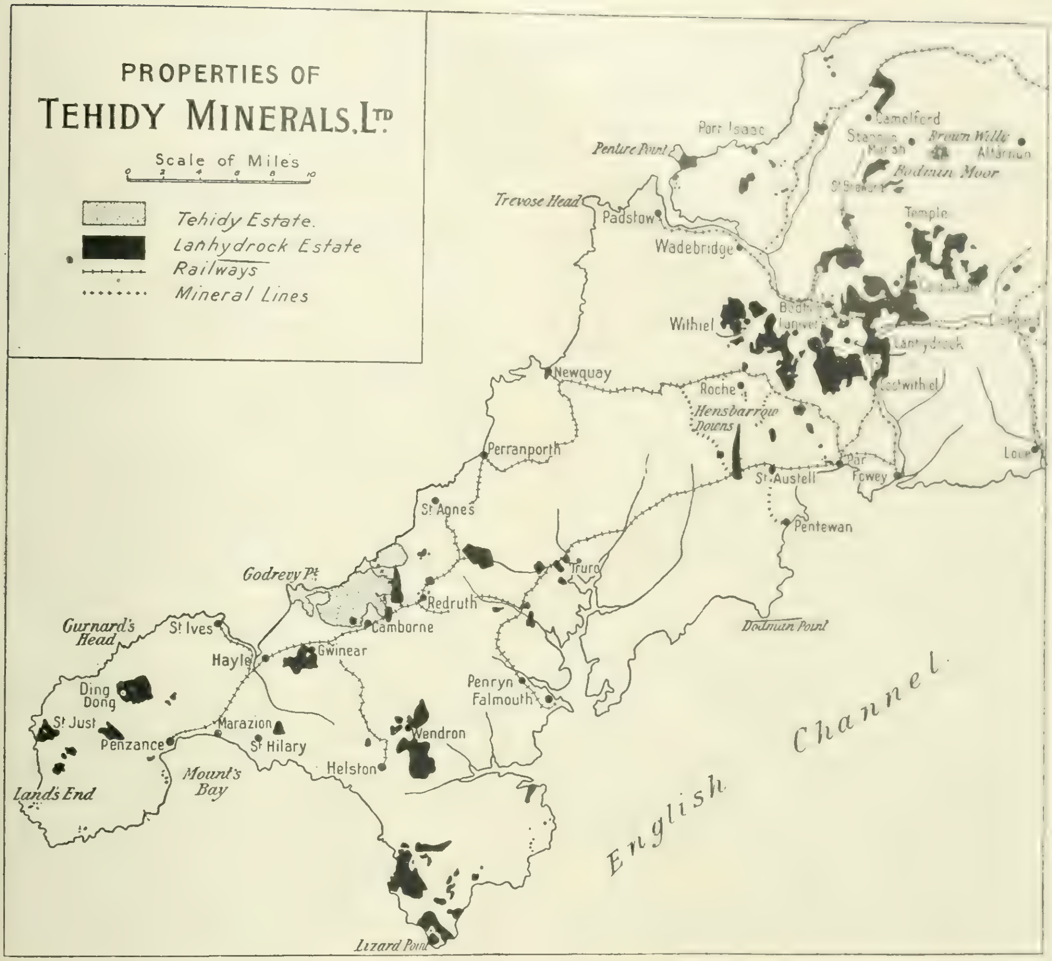
The rents and royalties for 1918 from these properties amounted to £15,000, making a total revenue from the Basset and Lanhydrock estates of nearly £20,000.

While the revenue from royalties and rents is expected to give a substantial return, it is evident that with such large china-clay and other mineral areas to develop a progressive policy of exploratory work is a prime essential for future prosperity. A large amount of attention has already been given by the general managers, Messrs. Bewick, Moreing & Co., to schemes for the economic exploration of the unexplored portions of the Redruth-Camborne line of tin mines. The necessary surveys and geological examinations have been made, the whole field having been carefully plotted in plan and section, indicating the probable lines of continuation of the famous Rogers and other lodes, which may be expected to be rich in the granite zone. The general managers engaged for this work Dr. Malcolm Maclaren.

An examination has just been completed of the clay areas by Dr. Maclaren, and the following extracts from his report serve to show the great possibilities for an expansion of this side of the company's operations: "There are altogether 15 probable and possible china-clay areas within the Tehidy Minerals, Ltd., properties in the Temple district. Of these seven are of first-class importance, five of secondary importance, and three of lesser value."

Referring to Porkellis Moor, Dr. Maclaren writes: "The moor has been worked and reworked for stream tin, and judging from the samples still obtainable must have been originally very rich indeed in cassiterite. The possible clay ground within the Tehidy Minerals area is about 1,100 yards long by 400 yards wide in the widest part. The peat and gravel overburden is very shallow, ranging from 2 to 8 ft. in the visible sections. So far as the gravel overburden is concerned I think that there is little doubt that the stream tin still to be obtained from it will fully repay the cost of removal when handled on an adequate scale. In view of the comparative proximity to the deep-water harbour of Falmouth, the Porkellis Moor area warrants immediate attention."

The statistics of the china-clay trade show a very steady and gratifying growth up to the year 1915, the total output then being close on 1,000,000 tons per annum, of which a large proportion was exported. Recent months have seen a marked revival in production, and the present year promises well. The china-clay industry has been regarded by those closely connected with it as a very lucrative one. The demand for the product has been steadily increasing, and fortunately Cornwall has practically a world monopoly of high-grade china-clays. Formerly these were largely used for pottery, but now by far the greater demand is from the paper trade. It is not necessary here



to say more of the china-clay industry, as it was fully dealt with by Mr. Henry F. Collins in recent issues of the Magazine.

In concluding their statement the directors say that the policy laid down by the board is to encourage in every way the development of this great property, not only by the old system of leases under royalties, but by taking participations in subsidiary companies formed for the development of the various mines and china-clay areas. The company will not, therefore, depend alone upon dividends arising from royalties, but should be able from time to time to distribute substantial bonuses in shares of these subsidiary enterprises, and plans are being matured in this direction. In addition thereto opportunities will no doubt arise for profitable sales of parts of the company's areas.

The company's statement goes on to say that the china-clay industry is apparently on the eve of further progress, as is evidenced by announcements made in the *Chemical Age* for January 17 to the effect that the clay can be used in soap-making in place of fats. According to these announcements, Mr. F. G. Weston, a chemist devoting his attention to colloids, claims that the colloidal clay, that is to say, the fine clay that will not settle from water, can be used in the manufacture of a substance which has the characteristics of soap. This substance is said to froth and remove grease and dirt. Presumably the inventor separates the clay from water by coagulation. Whether he uses this precipitate by itself or whether he mixes it with ordinary soap is not clear. In any case his description of the process is not easy to follow, and we hope we have interpreted him correctly. The directors of Tehidy Minerals refer to this process because it may give another outlet for the china-clay production.

THE ANALYSIS OF ALUMINIUM,

ITS COMPOUNDS, AND ALLOYS.

By J. E. CLENNELL, B.Sc., Assoc.Inst.M.M.

(Concluded from March issue, page 157).

CHAPTER VI.

GASOMETRIC METHODS OF DETERMINING METALLIC ALUMINIUM IN ALLOYS AND POWDERS.

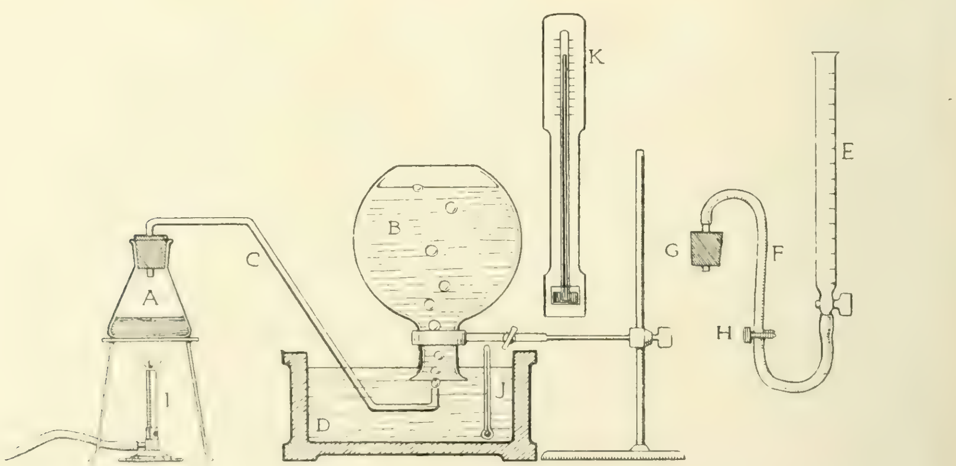
This method is applicable to sheet metal, foil, wire, granules, and dust. It depends on determining the volume, and hence by calculation the weight, of hydrogen evolved from acid or caustic alkali by a given weight of the sample. The result is obviously affected by the presence of any other metal which evolves hydrogen from the solvent used. Thus zinc and magnesium are determined as their equivalent of aluminium.

Preliminary Operations.—Determine the volume of the generating flask A by filling with water up to the point reached by the stopper when the flask is in use, and pouring this water into a burette or other convenient measuring vessel; also determine the volume of the liquid required to fill the leading tube C. Note the temperature and calculate the volume at standard temperature and pressure of the air which is contained in the generating flask and tube when connected as shown.

In the same way determine the volume of the collecting flask B to the mark on the neck reached by the stopper G when in use.

Solvents.—Hydrochloric acid, 25% by volume, is perhaps the most convenient solvent. Caustic soda, half normal, that is, 2% NaOH, may also be used. Dilute sulphuric acid may be used, but acts much more slowly than either of the above.

Blank Test to Determine Air Expelled.—In the flask A place 50 cc. of the solvent to be used subsequently in the actual test. Fill the flask B to the neck with water and invert over the bath. Fix the leading tube C in position. Heat gently to boiling, collecting the expelled air in B. Boil about 5 minutes after all air ceases to come off. Remove burner and allow water to flow back and fill A. A small bubble of air will remain in A, usually about 3 cc. Invert A in a sufficiently deep vessel of water. Remove C, which is now full of water, and transfer the bubble from A to B. Keeping the neck of B constantly immersed, fill the burette E and tube F with water and connect the stopper G with the neck of B. Open the clamp H and raise or lower the flask B until the level of liquid is the same in the flask and the burette, showing that the contained air is under atmospheric pressure. Close the tap of the burette, turn B to upright position and detach G. Measure the liquid remaining in B,



APPARATUS USED IN GASOMETRIC METHOD.

noting the temperature t and barometric pressure β. The difference between the volume of water originally filling B and the volume of water now contained represents the volume of air collected at the temperature t and pressure β. This volume (corrected to standard) should equal the original volume of A and C, less 50 cc., corrected to standard.

The correction to standard is made by using the formula $V_o = \frac{V(\beta - T)}{\Delta t}$

where V_o = Required volume at 0°C and 760 mm.

V = Actual observed volume at t°C and β mm. pressure.

β = Barometric pressure in mm.

T = Tension of aqueous vapour at t°C.

Δt = A function of t

$= 760\,(1 + 0{\cdot}003665\ t)$.

[Tables are published giving values of T and Δ for corresponding temperatures.]

Actual Test on Aluminium Sample.—Sheet metal or clippings should be cut into small pieces. Weigh out 200 to 500 mgr. of the sample. Place them in the flask A. Prepare the apparatus and arrange as already described and shown in the figure. Add in A 50 cc. of the solvent. Connect quickly with the receiver B, which has previously been filled with water and inverted over the bath. Allow the action to proceed in the cold until no more gas is evolved; then heat gently till action again ceases and the liquid is boiling. Boil gently for a further 5 minutes. Collect and measure the gas exactly as in the blank test. Calculate volume at standard temperature and pressure. Deduct corrected volume of air shown by the blank test. The difference is the corrected volume of hydrogen evolved from the given weight of aluminium alloy.

Reactions:

(*a*) With acid: $Al + 3HCl = AlCl_3 + 3H$

(*b*) With alkali: $Al + NaOH + H_2O = NaAlO_2 + 3H$

Data for Calculations:

1 cc. H at 0°C and 760 mm. pressure
$= 0{\cdot}08955$ mgr. H
$= 0{\cdot}8025$ mgr. Al

1 mgr. H $= 8{\cdot}9616$ mgr. Al assuming Al $= 27{\cdot}1$ and H $= 1{\cdot}008$

Correction for Expansion of Glass.—In accurate work a small correction is necessary for the expansion of the glass vessels used. These are generally calibrated to contain a definite amount when filled to a mark, at some definite temperature. When the measurement is made at a different temperature, the actual volume of the vessel may be calculated by means of a table such as that given in Sutton's Volumetric Analysis.

Correction for Solubility of Hydrogen.—There is also a correction for the solubility of hydrogen in the water used. This might be eliminated by collecting over water previously saturated with hydrogen.

Influence of Metallic Iron.—Presumably iron would give hydrogen with HCl, but not with caustic alkalis. The result with NaOH or KOH should therefore be lower, and approximate more closely to the true metallic aluminium contents. Actual tests, however, did not indicate any constant difference between the results with HCl and NaOH. When caustic alkali is used as the solvent there remains in the generating flask at the finish a small quantity of flocculent precipitate, apparently $Fe(OH)_3$ and silica, which forms a scum or froth and may entangle some bubbles of gas.

Chapter VII.

Evaluation of Reducing and Precipitating Power of Aluminium Dust.

(1). Ferric Sulphate Method.

Definition of "Reducing Power."— It must be understood that the figure obtained by this method represents the equivalent, in terms of metallic aluminium, of all the ingredients which, under the conditions of the test, have a reducing action on ferric sulphate. These may include metallic iron, copper, zinc, and magnesium. It does not appear, so far as my observations go, that the result is affected by paraffin, which is usually present in commercial dust.

Standard Solutions Required:

(*1*). *Ferric Sulphate.*—Mix 50 grm. of c.p. ferric sulphate with about 500 cc. of distilled water, add 100 cc. concentrated sulphuric acid, dilute nearly to 1,000 cc., heat in a large flask till everything dissolves, cool and make up to a litre with distilled water. Where many tests are to be made it is best to prepare a larger quantity, using the same proportions, as the solution will keep indefinitely.

(2). Permanganate.—Dissolve about 3·3 grm. of potassium permanganate in warm water. When completely dissolved, cool and dilute to a litre with distilled water. The value of this solution is best determined empirically on a sample of aluminium dust of known purity, which is carefully preserved and kept as a standard. It may, however, be checked, as described later, by determin-

ing the iron standard of the permanganate and calculating the aluminium standard.

Process of Determining Reducing Power.—Weigh out on an assay button balance 100 mgr. of the dust, using a glass or horn spatula, to avoid possible error due to the presence of magnetic particles. Transfer cautiously, to avoid loss by dusting, to a 300 cc. conical flask. This may be done by holding the scale pan by the forceps over the neck of the flask and tapping gently, finally brushing in the last portions. Add 100 cc. of the standard ferric sulphate solution, which must be cold at the start. Place a stopper with Bunsen valve in the neck of the flask. Heat gradually to boiling, and allow to boil very gently till everything, except perhaps a minute quantity of silica or carbon, has dissolved. There should be no visible effervescence. Cool the flask by immersion in running water. Remove the stopper and titrate with standard permanganate.

Method of Standardizing on Metallic Iron.—Weigh out 530 mgr. (more or less) of clean iron wire of known percentage of Fe. Dissolve in a 300 cc. flask with 100 cc. sulphuric acid, 12·5% H_2SO_4 by volume, that is, 12·5 cc. concentrated H_2SO_4 diluted to 100 cc., using a Bunsen valve as in the assay of the aluminium dust. Boil gently till dissolved. Cool and titrate with the standard permanganate.

Theoretically, the aluminium standard can be found by multiplying the iron standard by the factor 0·16177, the assumed reaction being:

$$3Fe_2(SO_4)_3 + 2Al = Al_2(SO_4)_3 + 6FeSO_4$$

Actually, however, a small part of the aluminium appears to dissolve directly in the sulphuric acid:

$$3H_2SO_4 + 2Al = Al_2(SO_4)_3 + 6H$$

without reducing ferric sulphate. With ordinary samples of aluminium dust, the factor 0·173 was found to give about the correct standard. Using a permanganate solution containing 3·3 grm. $KMnO_4$ per litre, 1 cc. of the permanganate = 5·9 mgr. Fe or 1·02 mgr. Al (approximately).

Reducing Action of Other Metals.—When certain other metals are present in the metallic form, they reduce ferric sulphate by analogous reactions, thus:

(*a*) $Cu + Fe_2(SO_4)_3 = CuSO_4 + 2FeSO_4$

(*b*) $Fe + Fe_2(SO_4)_3 = 3FeSO_4$

(*c*) $Mg + Fe_2(SO_4)_3 = MgSO_4 + 2FeSO_4$

(*d*) $Mn + Fe_2(SO_4)_3 = MnSO_4 + 2FeSO_4$

(*e*) $Zn + Fe_2(SO_4)_3 = ZnSO_4 + 2FeSO_4$

It will be seen from these reactions that each of the above metals has a lower reducing power per unit weight than aluminium has. Hence the purer the sample of dust, the more nearly the figure obtained by this test approaches the theoretical maximum. The calculated equivalents of other metals, taking Al as 1, are given below:

Aluminium 1·000	Magnesium 0·743
Copper 0·284	Manganese 0·329
Iron 0·485	Zinc 0·276

Factors Affecting Reduction of Ferric Sulphate.—The physical condition of the sample exerts an influence on the result. Granular material usually shows a slight effervescence and gives a different result from flaky or very fine powder of the same metallic contents. Samples that show considerable effervescence are better tested by the gasometric method described earlier. The temperature of the solvent solution at the beginning also has some influence; generally the most consistent results are obtained by starting with a cold solution. The test should not be heated too rapidly or violently, in order to avoid mechanical losses; on the other hand the reaction is not completed in a reasonable time in the cold, and it is necessary to see that everything soluble has actually dissolved. Before titration, the liquid should be cooled nearly or quite to room temperature, and the titration should not be too long delayed, as there is a possibility of re-oxidation. It is apparently unnecessary to work in an atmosphere of carbon dioxide, provided a Bunsen valve be used, the error due to oxidation being negligible.

II. Cupric Sulphate Method.

Determination of Reducing Power by Means of Cupric Sulphate.—Metallic aluminium replaces copper in accordance with the reaction:

$$2Al + 3CuSO_4 = 3Cu + Al_2(SO_4)_3$$

If, therefore, a weighed quantity of aluminium dust is agitated for some time with an excess of copper sulphate solution, slightly acidulated with H_2SO_4, an amount of copper is precipitated equivalent to the aluminium dissolved. After washing thoroughly by decantation, the copper is dissolved in dilute nitric acid and the amount determined by any convenient method, such as the well-known cyanide and iodide methods.

1 part by weight of Cu = 0·284 parts Al.

The method is of course subject to the error that copper may be precipitated by other metals, such as iron, zinc, and magnesium, which may be present in metallic form. Moreover, unless the material is very finely divided and thoroughly stirred, there is a danger of particles becoming coated with a layer of precipitated copper and thus failing to dissolve completely. It is doubtful if the method possesses any advantages over the ferric sulphate method above described.

Standard Method for Determining Precipitating Power of Aluminium Dust.

Object of Test.—This method is designed to give an estimation of the comparative precipitating value of different brands of dust when used with the ordinary pregnant solution obtained in cyaniding silver ores.

Solvent.—Prepare several litres of a solution containing approximately 0·15% KCN and 0·08% NaOH. This may be made from ordinary tap water, adding something more than the calculated amounts of cyanide and caustic soda to give the required strength. Heat gently and allow to settle thoroughly. Decant the settled liquid into another vessel. Filter, best under vacuum, to remove the precipitate of $CaCO_3$, etc. If not well settled, this liquor filters very slowly. Determine actual KCN and NaOH strength of the filtrate, and adjust if necessary.

Preparation of Test Solution.—For each test, fill a litre measuring flask to the mark with this solution. Remove 25 cc. of the liquid with a pipette, and use this to rinse out an ordinary glass bottle of a little more than 1 litre capacity and provided with a rubber stopper. A number of such bottles should be previously prepared and well cleansed with tap water, for use as test bottles, and should have as nearly as possible the same shape and capacity. Transfer the remaining solution (975 cc.) to the test bottle. Add from a burette exactly 25 cc. of the regular standard silver nitrate solution (13·0465 grm. $AgNO_3$ per litre). The mixture will now contain 207·11 mgr. Ag, equivalent to 6·05 oz. of silver per ton of solution.

Details of Test.—Now add to each test 500 mgr. of the aluminium dust. It is preferable to have the liquid slightly warm. Agitate briskly to mix thoroughly. The bottles are now attached to a wheel or any suitable agitating device and kept in motion without violent agitation for 15 minutes, then filtered immediately on a vacuum filter, using a double 11 cm. paper on a perforated porcelain funnel, collecting the filtrate in a Woulfe's bottle or vacuum flask. The liquid should filter very rapidly, and the funnel should be kept filled until the end of the operation. It is not necessary to wash out the whole of the precipitate from the bottle nor to use any water-wash on the filter.

Transfer papers with precipitate to a large evaporating dish or casserole, taking care to remove any particles adhering to the funnel. Pour into the test bottle 25 cc. of nitric acid (50% HNO_3 by volume), rinse the bottle with this, and see that all adhering particles of precipitate are dissolved. Pour the liquid into a dish and rinse out the bottle once or twice with a little water, adding these washings to the dish. Heat gradually to boiling and stir till action ceases and red fumes are no longer evolved, but avoid disintegrating the paper. Pour the liquid into a 200 cc. flask. Wash the papers 4 times with hot water, adding the washings. Cool the flask to room temperature. Add a few drops of ferric indicator (ferric nitrate, sulphate, or ferric alum). Titrate the silver with standard thiocyanate.

Modifications for Use with Weaker Solutions.—The quantities of cyanide, caustic soda, silver nitrate, and aluminium dust may be varied according to the conditions of practice which it is desired to imitate. The amounts given above are suitable for an ordinary case in which the solution before precipitation would carry about 6 oz. silver per ton.

For low-grade solutions we might use, for example, 0·1% KCN, 0·07% NaOH, 6·2 cc. $AgNO_3$ (=1·5 oz. Ag per ton) and 125 mgr. of Al dust, otherwise proceeding as above detailed.

To Standardize the Thiocyanate Solution.—Take 25 cc. of the standard silver nitrate solution. Add 25 cc. of the 50% HNO_3. Boil, cool, dilute to about 100 cc., and titrate with standard KCNS, using ferric indicator as in the assay. It is convenient to adjust the thiocyanate so that it corresponds exactly volume for volume with the silver nitrate. In any case the percentage of precipitation is found by the formula:

$$\frac{\text{No. of cc. KCNS in actual test}}{\text{No. of cc. KCNS used in standardizing}} \times 100$$

The standard thiocyanate is made by weighing roughly 10 grm. potassium thiocyanate, dissolving in water, and diluting to a litre, titrating as above, and adjusting to required strength by adding water.

Tests on the Filtrate to Verify Efficiency of Precipitation.—The solution after precipitation and filtration may be tested as follows:

(*1*) Add to a portion a few drops of sodium sulphide solution. If the precipitation is incomplete this will give a brown colouration. With good precipitation there is no reaction.

(*2*) Add potassium iodide indicator, and titrate the cyanide strength. By comparing this with the strength of the original solution, the amount of cyanide regenerated can be calculated.

(*3*) After adding a slight excess of silver nitrate add phenol-phthalein and titrate alkalinity with standard acid.

(*4*) Estimate the unprecipitated silver in a portion (say 10 A.T. or $291\frac{1}{6}$ cc.) of the filtrate by the regular fire assay or the author's volumetric method.

CHAPTER VIII.

DETAILS OF ANALYSIS OF ALUMINIUM DUST.

Scheme for the Separation and Estimation of the Minor Constituents in Aluminium Dust.

Composition of Aluminium Dust.—The ingredients commonly present in this product are metallic aluminium, alumina, iron, ferrous or ferric oxides, copper, lead, manganese, zinc, magnesium, silicon, carbon, grease (the latter usually some form of solid paraffin), and moisture. Metallic aluminium is commonly found by difference, after determination of all other constituents. Arsenic, antimony, cadmium, and other impurities have been indicated in minute amounts, and such substances as calcium carbonate may occasionally be found as accidental impurities.

Arrangement of Analysis.—It is possible to determine all the ordinary ingredients in one weighed portion, but it is preferable and more expeditious to work simultaneously on two, or better three portions.

Using 2 portions only, we may determine in No. 1 moisture, grease, iron, copper, and in No. 2 silicon, alumina, manganese, magnesium, zinc.

Using 3 portions, the following, among many possible arrangements, is suitable :

No. 1. Moisture, iron, copper.

No. 2. Grease, manganese, magnesium, zinc.

No. 3. Silicon, alumina.

One gram is commonly taken for each portion.

In some cases it is advantageous to make rapid determinations of one ingredient only ; this can readily be done in the case of iron and manganese.

The scheme of separation for three weighed portions is detailed below.

Portion No. 1. Moisture, Iron, Copper.—Prepare steam-oven for several hours' run. Weigh a small watch-glass (say 6 or 7 grm. weight). Add 1 grm. to the weights in the pan counterpoising the watch-glass, and add aluminium dust from the sample to be analysed, using a glass or horn spatula to transfer from sample bottle to watch-glass, until equilibrium is reached. Place watch-glass containing weighed quantity of dust in the steam-oven, supported on a clay triangle, and maintain at (say) 98°C. Allow to cool under cover, best in a dessicator, for 10 minutes before weighing. Return to steam-oven and re-weigh at intervals of about an hour till constant weight is obtained. The loss of weight represents moisture.

Usually after prolonged drying, the weight begins to increase again, so that the lowest weight recorded is assumed to be correct.

Brush the dried sample from the watch-glass into a 300 cc. conical flask A. Add 100 cc. dilute sulphuric acid (12·5 cc. conc. H_2SO_4 diluted to 100 cc.). Agitate, heat gradually to boiling, removing from the flame if the action is too violent, which is seldom the case with this strength of H_2SO_4. In about 15 to 20 minutes most of the material will have dissolved, leaving only silicious matter, grease, and larger flakes of aluminium. Filter through a 9 cm. paper into a 300 cc. conical flask B. Wash out flask A and paper once or twice with hot water. It is unnecessary to transfer all the residue to the paper. Place the paper, opened, in a porcelain casserole, add 10 cc. 50% HCl and 5 cc. 50% HNO_3. Warm and agitate, finally heat just to boiling without disintegrating the paper. Pour liquid into flask A. Wash once or twice with a little hot water.

If the paper is perfectly clean, it may be rejected. In this case add to A 5 to 10 cc. of conc. H_2SO_4, boil down to white fumes, cool, dilute, and add contents to B. Otherwise transfer the paper to a nickel crucible. Heat over a small flame till dry, ignite, add enough sodium peroxide to cover the ash. Fuse at a gentle heat (about 1 minute is sufficient), cool, extract with a little hot water, adding extract to flask A. Clean the crucible and add rinsings. To A add 10 cc. conc. H_2SO_4 and boil to white fumes. Cool, add 50 cc. water, boil and filter into flask B, which already contains the bulk of the material soluble in H_2SO_4. Wash thoroughly, transferring residue to filter. Flask B now contains all the iron, together with Al, Cu, Mn, Zn, and Mg, dissolved in H_2SO_4 and the bulk of liquid is probably about 200 cc.

Add 3 or 4 pieces of stout pure aluminium foil, perfectly free from iron, and bent at the corners. Boil gently for half an hour, using a Bunsen valve. Filter through a 9 cm. paper into a clean 300 cc. flask. Wash rapidly two or three times with a little hot water, retaining the aluminium sheets in the boiling flask B. Cool rapidly and titrate iron with permanganate.

A convenient standard of permanganate for this purpose contains 0·566 grm. $KMnO_4$ per litre, so that 1 cc. equals approximately 1 mgr. Fe, but the exact litre should be determined by means of pure iron wire or an iron salt of known contents.

It is well to test the completeness of the copper precipitation by adding to the liquid, after titrating with $KMnO_4$, a few drops of H_2S water or Na_2S solution; some sulphur may be precipitated, but there should be no darkening.

Place the flask B containing the aluminium sheets under the funnel containing the filter last used. Heat 10 cc. of 50% nitric acid just to boiling in a separate flask and pour through the filter. Exchange flasks; see that all copper dissolves, warming if necessary, but do not boil with the aluminium sheets. It is sufficient to agitate with the hot liquor. Again pour through filter, wash once or twice with hot water, retaining the aluminium sheets in flask B. Heat the filtrate to boiling to expel nitrous fumes. Cool, add 10 cc. strong ammonia, and again cool. Titrate the copper with standard cyanide.

The standard solution contains about 10 grm. KCN or 7·5 grm. NaCN per litre. It may be standardized on pure copper foil as follows: Weigh 5 mgr. (about) of copper foil, determining the exact weight. Dissolve in 10 cc. 50% nitric acid. Boil off red fumes. Dilute to 50 cc., cool, add 10 cc. strong ammonia. Cool to room temperature. Titrate exactly as in the analysis. It is best to do this simultaneously, diluting both tests to the same volume, and adding the standard cyanide a little at a time, alternately to each. If desired, the standard cyanide may be adjusted so that 1 cc. = 1 mgr. Cu.

Portion No. 2. Grease, Manganese, Magnesium, Zinc.—Clean a 50 cc. conical flask with petrol and finally with ether. Dry, cool, and weigh. Place under a clean dry funnel, with dry 9 cm. paper.

Clean and dry a 150 cc. beaker. Weigh 1 grm. of the dust. Transfer to beaker. Add sufficient ether to cover. Stir with glass rod and settle a moment. Filter into the 50 cc. flask. Continue adding ether in small quantities, stirring and filtering, till about 30 cc. of filtrate has been collected. This generally suffices for the extraction of grease, but the completeness of extraction may be confirmed by passing a few more drops of ether and collecting in a watch-glass. These should leave no residue on evaporation. Connect the 50 cc. flask by means of a bent glass tube and cork with a condenser, using a clean dry flask as receiver. Heat by immersing in boiling water and continue until no more distillate is obtained. Keep the receiver cool by immersion in cold water. Detach 50 cc. flask, allow to cool. See that no water has condensed outside or inside. If necessary place in steam-oven for a time. Cool and weigh. Increase of weight equals grease.

Cautiously dry the residue in the beaker, together with the filter-paper, containing the part carried over by the ether during the filtration. Brush as much as possible from beaker and paper into a 300 cc. flask A. Add 50 cc. water and place under a funnel containing the filter-paper. In the beaker place 50 cc. of 25% HCl. Heat to boiling. Pour slowly through filter, collecting in flask A. Rinse out beaker with hot water and pour this through filter. Replace flask A by a clean 300 cc. flask B. Heat flask A slowly to boiling. When most of the action is over, add 5 cc. of 50% HNO_3. Boil thoroughly. Filter through the same paper as before into flask B. Wash well with hot water, transferring all residue to paper.

[If the residue is considerable, the filter-paper may be removed and dried in a nickel crucible, ignited, and the ash fused with a little sodium peroxide. The melt is then dissolved in water and the solution added to the liquid in flask B, filtering if there is still any considerable matter undissolved.]

While the liquid in flask B is still hot, but not boiling, add caustic soda in small pieces, one at a time, or in very concentrated solution, agitate, warm if necessary, until the $Al(OH)_3$ first thrown down has re-dissolved, leaving a reddish or brownish residue. Dilute to about 150 cc, add a few cc. of strong bromine water, boil, settle, filter into a 300 cc. flask C. Wash 3 or 4 times with hot water. Residue contains Mn, Mg, Fe, Cu; proceed under (1). Filtrate contains Al, Zn, a little Fe; proceed under (4).

(1) Heat the residue with about 15 cc. of 50% HCl in a small flask. Pour through filter and collect in flask B. See that the residue completely dissolves. If any brown stains remain on the paper add a few drops of SO_2 water or a concentrated solution of sodium bisulphite. Wash 3 or 4 times with hot water. To filtrate add a slight excess of ammonia and about 10 cc. of strong bromine water. Boil thoroughly. Filter into a clean 200 cc.

flask D. Wash once or twice with hot water. Residue equals Fe, Mn; proceed to (2). Filtrate equals Cu, Mg; proceed to (3).

(2) Heat 50 cc. of 25% HNO_3 to boiling. Pour through filter, collecting filtrate in flask B. Wash with 25 to 30 cc. hot water, dissolving any stains with SO_2 as before. Boil filtrate thoroughly to expel nitrous fumes and SO_2. Add 1·5 cc. standard silver nitrate; again boil for a minute. If much chloride is indicated, add more silver nitrate and filter again. Add 0·5 grm. lead peroxide. Boil 1 minute. Cool, dilute to 100 cc., agitate, settle 5 minutes. Filter through dry filter paper, rejecting the first few cc. passing. Take 50 cc. of the filtrate and titrate manganese with standard sodium arsenite till the pink tint changes to pale yellow. [For preparation of arsenite solution see below. It is best adjusted so that 1 cc. = 0·5 mgr. Mn.]

(3) Concentrate by evaporation, if necessary, to about 50 cc., cool, add 10 cc. ammonia and 10 cc. of 5% sodium phosphate. Agitate vigorously. Allow to stand covered overnight. Filter, rinsing all precipitate on to the filter with portions of the filtrate, rubbing the sides of the flask with rubber-tipped glass rod. Finally wash on filter with 100 cc. of 10% ammonia. Dry, ignite, and weigh as $Mg_2P_2O_7$.

$Mg_2P_2O_7 \times 0{\cdot}219 =$ magnesium.

(4) To the filtrate in flask C add a few drops of strong sodium sulphide solution, or pass in H_2S. Boil, allow to settle, filter, wash once or twice with hot water containing H_2S. Residue equals ZnS with a little Al and Fe. Filtrate equals aluminium; reject.

Pour through the filter 10 cc. of boiling 50% HCl. Collect filtrate in flask C. Boil to expel H_2S. Add about 2 cc. conc. HNO_3. Boil, add ammonia in slight excess, boil, filter, wash 3 or 4 times with hot water. Residue equals $Fe(OH)_3$ and $Al(OH)_3$; reject.

To the filtrate add a few drops of strong sodium sulphide solution, boil, settle, filter through double 9 cm. paper, and wash with hot water till washings give no reaction with lead acetate, showing absence of soluble sulphide.

Place the two papers in separate flasks. Cover with cold water. Add to each 10 cc. of $\frac{N}{10}$ iodine. Place stoppers in necks of flasks and agitate gently. Allow to stand a few minutes. Titrate with $\frac{N}{10}$ thiosulphate till colour nearly disappears, then acidulate with HCl, add starch and finish titration carefully with thiosulphate till blue tint just disappears. The reaction is:

$ZnS + I_2 = ZnI_2 + S.$

Difference of titrations $\times$ 32·7 = Zn (mgr.)

The amount of zinc is generally too small for estimation by the ferrocyanide method.

Portion No. 3. Silicon, Alumina.—Weigh out 1 grm. of the dust. Transfer to a 300 cc. flask. Add 100 cc. dilute HCl (12·5 cc. conc. HCl diluted to 100 cc.). Heat cautiously to boiling, with constant agitation. Boil till nearly everything has dissolved. Filter through a double 9 cm. paper. Transfer all residue to the paper and wash with hot water. With a fine jet wash off the residue into a casserole, and add in same 10 cc. 50% HCl and 5 cc. 50% HNO_3. Boil, dilute if necessary, and re-filter through same double filter as before. Wash free from chlorine. Separate the two papers and ignite in separate porcelain crucibles. The difference of the two weights represents "insoluble," or $\frac{\text{diff. in mgr.}}{10}$ = insoluble per cent consisting of silica, alumina, and some ferric oxide.

Transfer the two residues separately to nickel crucibles. Add enough sodium peroxide to cover the ash. Fuse at a low temperature for about 1 minute. Cool, extract with water into evaporating basins. Acidulate slightly with HCl. Evaporate to dryness. Add HCl and again evaporate to dryness. Take up with 25 cc. 50% HCl, boil, dilute, filter, wash with hot water till free from chlorides. Dry, ignite in porcelain crucibles, and weigh. Difference in weights equals silica.

The weight of insoluble, less weight of silica is generally reported as alumina, but sometimes contains a little ferric oxide or graphitic carbon.

The filtrate from "insoluble" may be used for determination of Mn, Mg, and Zn.

Silica $\times$ 0·4702 = silicon

Additional Remarks on the Estimation of Silicon in Aluminium Dust.

According to Seligman and Willott ("The Analysis of Aluminium and its Alloys," *Journ. Inst. Metals 3* (1), 1910, p. 138) a loss of silicon occurs on dissolving the alloy in hydrochloric acid (or a mixture of HCl and H_2SO_4) owing to volatilization of Si as silicon hydride (SiH_4). Silicon may occur both in the elemental form (Si), and as silica SiO_2 (possibly also as alumino-silicide of iron). These writers recommend the following:

(1). If only the *total silicon*, including that present as silica, is required, 1 grm. of the sample is dissolved in 5 cc. concentrated HNO_3, 20 to 25 cc. of 25% H_2SO_4, and a sufficient quantity of concentrated HCl added to dissolve everything soluble in acid, adding the latter cautiously to avoid violent action. The mixture is then evaporated slowly till salts begin to crystallize out, then covered and heat continued till all moisture is expelled and fumes of SO_3 are freely evolved. After cooling, water is added, and boiled till all aluminium sulphate has dissolved, filtered through a fine paper, washed very thoroughly, and the residue ignited strongly, to constant weight, when it is assumed to be completely converted to SiO_2, or preferably fused with alkali carbonate, re-dissolved in acid, and again evaporated as in an ordinary silica determination.

(2). When the *elemental silicon* is to be determined separately, the sample is dissolved in HCl + H_2SO_4 without adding HNO_3. The flask is connected with receivers containing successively bromine water and ammonia water, which retain any volatilized SiH_4. These wash solutions are subsequently evaporated to recover any SiO_2 contained. The main solution, containing all the graphitic silicon and the bulk of combined Si in the form of silicic acid, is evaporated down, taken up with water as in the method for total silicon, insoluble matter collected on a weighed filter, thoroughly washed and slowly dried to constant weight. This, together with the weight of Si obtained from the wash solutions used to collect the volatilized SiH_4, gives the entire amount of Si + SiO_2. By calculation from the assay of total silicon, the amount present as SiO_2 can now be found.

[As the insoluble residue may possibly contain alumina and ferric oxide in addition to silicon and silica, I should prefer to fuse with pure sodium peroxide, separate the SiO_2 in the solution of the melt, and determine Fe and Al in the filtrate from the SiO_2.]

Special Method for Estimation of Manganese in Aluminium Dust.

Weigh out 1 grm. of the dust. Transfer to a 300 cc. flask. Add 50 cc. of 50% nitric acid. Heat gently with constant agitation until violent action sets in, with copious evolution of red fumes. Withdraw from heat and cool if necessary by immersion in cold water till violent action ceases, then boil to expel red fumes. Filter into another 300 cc. flask, rinsing out the first flask once or twice with hot water and passing the washings through filter. Place filter paper in a nickel crucible, dry, ignite, add enough sodium peroxide to cover the ash. Fuse at a gentle heat for about 1 minute. Dissolve melt in water and add to nitric acid extract. Boil well. Add 1 to 1·5 cc. of standard silver nitrate (13·04 grm. $AgNO_3$ per litre) to ensure absence of chlorides, and again boil for a moment. Add 100 mgr. of lead peroxide for every mgr. of Mn supposed to be present. Boil one minute, cool, make up to 100 cc., mix thoroughly. Settle about 5 minutes. Filter, rejecting first portion passing through, and titrate 50 cc. of the filtrate with standard sodium arsenite solution. If liquid is not clear, re-filter before titration.

Preparation and Standardization of Sodium Arsenite.—A strong stock solution is first prepared by dissolving 10 grm. of arsenious acid (As_2O_3) and 30 grm. of sodium carbonate in boiling water. When dissolved, cool, and dilute to 1,000 cc. To prepare the standard solution take 62·5 cc. of this stock solution and dilute to 1 litre.

This may be standardized on any manganese compound of known composition. It may be conveniently done with c.p. manganese carbonate. Weigh out 2·092 grm. of the carbonate ($MnCO_3$) and dissolve in 20 cc. of 50% HNO_3, adding SO_2 or a few drops of sodium bisulphite solution if not clear. Boil thoroughly, cool, dilute to 1,000 cc. 1 cc. = 1 mgr. Mn.

Take 5 cc. of the above manganese solution, add 25 cc. 50% HNO_3 and 50 cc. water. Boil, add 1·5 cc. standard $AgNO_3$. Boil, add 0·5 grm. lead peroxide. Boil 1 minute, cool, dilute to 100 cc., and proceed as in the assay.

LETTER TO THE EDITOR

The Poldice Dumps.

The Editor:

Sir—In the February number of the Magazine your Camborne correspondent mentions the then recently issued report by the directors of the Berrida company.

I wish to point out that it was not recorded by me nor was it intended in the company's published report to be conveyed that 75% of the *whole* of the material in dumps on Poldice would pass a screen of 1½ in. aperture. My statements on the subject were that sampling *certain* of the dumps proved that 75% of the tin was contained in that portion of the material which would pass a 1½ in. screen.

In the same notice mention is made of a quantity of material treated giving by chemical assay 14 lb. black tin and 10% of arsenic per ton. This last figure is a mistake. The report correctly gave the arsenic as 1%.

H. HANNAY.

St. Day, Cornwall,
March 9.

NEWS LETTERS.

TORONTO.

March 13.

MINERAL PRODUCTION DURING 1919.—The preliminary report of the Mineral Production of Canada during 1919, issued by the Department of Mines, gives the total estimated value as $173,075,000, being less than that of the three preceding years. The output of 1918 was valued at $211,301,897, showing a decrease of 18%. This is of course due to the cessation of the war demand for metals and minerals, and the industrial dislocation of the reconstruction period. The metallic production was valued at $72,401,829, the quantities and values of the principal items being as follows: cobalt 336,185 lb., $840,463; copper 75,124,653 lb., $14,041,549; gold 767,167 oz., $15,858,749; lead 43,895,888 lb., $3,057,788: nickel 44,542,953 lb., $17,817,181; silver 15,675,134 oz., $17,418,522, and zinc 31,738,859 lb., $2,328,998. All these items with the exception of gold show a decrease.

PORCUPINE.—The annual statement of the Hollinger Consolidated shows that 1919 was the best year in the company's history. Gold was recovered to the value of $6,722,266, and other sources of income brought the total receipts up to $7,065,099. The net profits were $2,321,290, out of which $1,722,000 was paid in dividends and $599,290 added to the surplus, bringing the total up to $5,738,053. The total quantity of ore treated was 711,882 tons, of the average value of $9·73 per ton. The amount of the ore reserves was estimated at 39,928,430 tons, as compared with 41,050,005 tons last year. The report announced the purchase by the company of an oil property comprising 3,760 acres in Kansas for $115,195. An official statement of operations at the Dome Mines, concerning which little reliable information had been forthcoming for some time, announces that from the time of the reopening of the mill in June up to the end of the year the company had treated 187,580 tons of ore, averaging approximately $7 per ton, with a total recovery of $1,290,301, or about $6·87 per ton. The option held by the company on the Dome Extension had been extended to September 15, the work of exploration having been much retarded by flooding and labour shortage. An ore-body of about 14,000 square feet, samples of which show an average value of $4·62, has been disclosed on the 600 ft. level. The main shaft of the Clifton Porcupine is down 225 ft., and lateral work has been started on the 200 ft. level where the veins continue strong. The Keora has been equipped with a complete mining plant and is sinking to the 250 ft. level.

KIRKLAND LAKE.—Operations are now being actively carried on several miles east of the known gold-producing zone by a number of new companies. The same geological conditions have been found to prevail as those characteristic of the proved area, and surface indications are highly promising. The Lake Shore during January treated 1,765 tons of ore, recovering an average of $25·80 per ton, with a total production of $45,428. The Wright-Hargreaves is preparing for the installation of a mill of 200 tons daily capacity, which will be the largest mill in the camp. The Tough Oakes is still closed, as Col. H. H. Johnson, the general manager, has not yet returned from South Africa. The shaft on the Canadian-Kirkland, where a large body of high-grade ore is indicated at depth, is now down 180 ft. and cross-cutting has been begun at the 150 ft. level. The Ontario-Kirkland is opening up rich ore on the 300 ft. level. At the Bidgood property in the new territory to the east, ore is being opened up on the surface where there are several good veins, in one of which channel assays show an average gold content of $13·50 per ton over a width of 5 ft. The company has got in a mining equipment.

COBALT.—The increasing demand for cobalt is likely to result in the reopening of some closed-down mines for the extraction of this metal, which in the early period of the district was treated as almost a negligible quantity. It is believed that at present prices its production would be profitable irrespective of the occurrence of silver. The Nipissing during February mined ore of an estimated value of $307,485, and shipped bullion from Nipissing and customs ores of an estimated net value of $409,523. Exploration work resulted in the discovery of a promising new vein. The Chambers-Ferland has during recent months blocked out ore to the approximate value of $150,000. The Oxford-Cobalt has placed a contract for the sinking of a shaft to a depth of 200 ft. The Kerr Lake during February produced approximately 100,000 oz. of silver. With the payment of its regular quarterly 3% dividend next month, the McKinley-Darragh will have returned to its shareholders a total amount of $5,754,163, or 259% on its capitalization. It is carrying on further explorations on the Savage property. Development at the 90 ft. level of the University property of the La Rose has disclosed a 30 ft. wide ore-body of high grade. A new high-grade vein has been found on the Princess property. The present rate of production by the La Rose is the highest for several years. The Coniagas has started to operate the former Trethewey property, which it recently acquired.

GOWGANDA.—Driving on the Trethewey property at the 108 ft. level has been carried 220 ft. with good ore all the way. A second shipment of ore, estimated to contain 100,000 oz. of silver, will shortly be made. The Kilpatrick claims have been taken over by a new company known as the Kilpatrick Silver Mines. A shaft will be sunk on a strong outcropping vein. The Silver Bullion has purchased a mining plant costing $30,000, which will shortly be in operation. The Bonsall claims are being sampled to determine the most promising spot for beginning development.

BOSTON CREEK.—At the Peerless, formerly the Mondean, a rich vein 5 ft. wide has dipped into the shaft between the 100 and 200 ft. levels. The Boston-Kennedy, having put a shaft down 100 ft. with satisfactory results, has let a $10,000 contract for further development work. A mining plant is being brought in.

VICTORIA, B.C.

February 18.

TRAIL.—The Consolidated Mining & Smelting Co. is making a number of improvements at its smelter. Owing to the fact that it has made arrangements for the treatment of the whole of the Canada Copper Corporation's output, which it is expected will average 130 tons of concentrate containing 25% of copper per day, the Consolidated company is increasing the capacity of its copper refinery from 20 to 50 tons per day. The company is installing a mill for the production of rod copper for the manufacture of copper wire. Previously Canada has imported all its rod and bar copper. In 1918 it imported 14,796,200 pounds of rod and bar copper, for which $3,787,521 was paid. A large proportion of this should in future be produced at the Trail smelter, and, considering the depreciation of Canadian currency in the United States, this will be a considerable advantage to the country. These and other improvements that have been made recently have necessitated doubling the space in the machine shop and the introduction of a considerable amount of new machinery.

G. S. Blaylock, general manager of the company, announced recently that, as the Provincial Government did not intend to grant a conciliation board, as requested by the One Big Union in connection with the Sullivan mine strike, there was no longer anything in the way of the company's granting a 50 cent rise to all its men, which it had had under consideration for some time. The rise went into effect at all the company's mining camps and at its smelter on February 16. The Sullivan mine is now producing all the ore that the new experimental 600-ton concentrator is capable of handling. The quantity of ore received at the smelter for the first month in the present year totalled 34,278 tons.

GRANBY.—The Granby Consolidated Mining, Smelting, & Power Co. will hold an extraordinary meeting of the company for the purpose of increasing the capital of the company from $20,000,000 to $25,000,000 on February 25. The company has been put to considerable expense in the development and equipment of its new colliery at Cassidy, on Vancouver Island, and in the erection of the battery of coke ovens and other improvements at its smelter at Anyox. It had been the intention to pay for these improvements out of profits, but the unfortunate position of the copper market since the signing of the armistice has prevented this and made it necessary to raise the needed funds by subscription.

The case of the Esquimalt & Nanaimo Railway Co. *versus* the executors of the late Joseph Ganner is occupying the attention of the British Columbia courts. The railway company asks that the Crown grant issued by the Provincial Government be declared null and void and that an injunction be placed on the defendants, restraining them from mining coal or from registering or applying to register any surface rights. The railway company claims that the land had been granted to them by the Dominion Government, and, consequently, the Provincial Government had no right to grant it to Joseph Ganner. The case is of particular interest to mining men, in that it was this piece of land that the Ganner estate sold to the Granby Consolidated company, and on it it has developed its Cassidy colliery, which is producing 10,000 tons of coal per month, and built a model settlement for its employees, and the doing of this has involved the expenditure of more than $2,000,000.

ENGINEER MINE.—W. Pollard Grant has begun an action in the Supreme Court against the Gold Commissioner and the Mining Recorder at Atlin, for a one-fifth interest in the Engineer mine, at that place. Pollard Grant alleges that the mine is about to be sold for $3,000,000. The Engineer mine has produced richer gold quartz that any other mine in British Columbia. Some 25 veins have been exposed by surface-stripping and open-cutting, and by the crudest forms of mining and metallurgy the mine kept its late owner in affluence. About 18 months ago engineers made an examination of the property for the Mining Corporation of Canada, but they, together with Captain Alexander, the owner of the mine, were lost on the ill-fated Princess Sophia, on their return from the property to Vancouver. Since then no work has been done on the property. Last fall, engineers representing a strong United States syndicate made an examination of the mine, and it is supposed it is this syndicate to whom Mr. Grant alleges the mine is about to be sold.

WIRE ROPE MANUFACTURE.—The Britannia Wire Rope Co. has been organized with the object of erecting a factory on Granville island, Vancouver, for the manufacture of wire rope. The plans have been completed and the necessary machinery has been purchased in Great Britain, and is now on its way to Vancouver. The company has been financed by British capital and nothing but British material is to be used in making the ropes.

OIL EXPLORATION.—The Hon. T. D. Pattullo, Minister of Lands, recently placed Professor Gwillim's report on the possibilities of oil in the Peace River country on the table of the local House. Mr. Pattullo stated that the exploration work would be continued this year. No account of the expense of the investigation was given. At the last sitting of the Legislature $50,000 was appropriated for the purpose, and it hardly seems possible that Professor Gwillim and his assistants can have absorbed that amount in a summer's work.

SALMON RIVER.—An unfortunate dispute has existed for some time between the management and the employees at the Premier mine, with the result that the output will be considerably less than was anticipated. The mine has been idle on and off for a good part of the winter, and, up to now, only one shipment of ore has been made, though there is another awaiting a steamer at tide-water. At the time of writing the men are once again on strike. The One Big Union seems to have obtained a foothold in the camp, and where that is trouble invariably is there also. With the view to accommodating those from below the 49th parallel who desire to participate in the rush to this district, the Admiral line of steamships has announced that it will make Hyder a port of call this spring and summer.

ALICE ARM.—The Taylor Mining Co. has been mining ore from the rich strike that was made about two months ago in the Dolly Varden mine, and is sending about 2½ tons of ore per day by dog and horse teams over the 18 miles to tide-water. The ore is unusually rich, some of it containing heavy plate silver, reminding one of Cobalt ore. The ore is being shipped to the Selby smelter, on San Francisco Bay. The company is establishing a camp at the Wolf mine, and, as soon as weather permits, will extend the Dolly Varden railway to the Wolf mine. This extension will enable the Musketeer, Toric, Tiger, and North Star mines to ship their output by rail to tide-water. There is a considerable amount of ore ready for shipping at the North Star. Price & Keith, of New York, have bonded the Last Chance mine and E. Pickell's property, and have a diamond-drill at work on the former of these.

SLOCAN.—The Silversmith Mines, Ltd., has called in its seven-per-cent preferred stock, and will issue common to take its place. Up to the end of 1919 the company had issued common to the value of $103,043 and preferred to the value of $165,192. During the year 14,558 tons of ore was mined, of which 325 tons of high-grade was shipped direct to the smelter. The balance was concentrated and the concentrates were shipped partly to Trail and partly to smelters in the United States. Nearly all the zinc concentrate was shipped to the United States. The last shipment of 84 tons of concentrate to the United States S.R. & M. Co. gave a return of $14,931, after all charges had been paid.

The Standard mine, at Silverton, which has been confining its work mainly to development, started shipping again in the fall, and in December it showed a profit of $30,000, against $7,600 for the previous month. A number of properties have changed hands recently, and more activity is being shown than for many years.

NELSON.—The long tunnel from the Motherlode into the Nugget property has cut the Nugget main vein at a depth of 625 ft. At the point of intersection the vein was 12 ft. wide, 16 in. on the foot-wall running $17 in gold per ton and 3 ft. on the hanging wall running $33·60. The tunnel is being continued to cut the other four veins. Drifts have been started in each direction, and, at the time of writing, have been extended 10 ft. The face on the east side has 4 ft. of ore assaying $88 per ton and on the west 4 ft. assaying $44. About 8 ft. of ore in the centre of the vein is almost barren quartz. A strike of 7 ft. of high-grade milling ore has been made in the 210 ft. level at the Tango group. The surface croppings are rich in gold.

MELBOURNE.

February 4.

YAMPI IRON ORE.—"One of the great iron ore deposits of the world" is the latest claim which, on the authority of the State Mining Engineer, Mr. A. Montgomery, West Australia can advance. The deposits are at Yampi Sound on the north-west coast. The cliffs are of unusually pure iron ore, rising from deep water to a height of hundreds of feet, and the reserves are estimated at 97,300,000 tons above high-water mark.

Arising out of representations made to him the Minister for Mines, Mr. J. Scaddan, directed the State Mining Engineer to visit Yampi Sound to investigate the extent and quality of the iron ore deposits. A report by Mr. Montgomery, dealing with the results of his examination of the field, will be issued by the Government Printer at an early date. In the meantime, the following official summary of the report gives interesting facts regarding the deposits.

The deposits are on the north-west coast, on Koolan and Cockatoo Islands, at the north-east side of the entrance to King's Sound, of which Yampi Sound is an outlying portion between the above islands, Irvine and Bathurst Islands on the north side and the mainland, Admiral, King Hall, and adjacent islands on the south side. A fact of the greatest importance to the working of the iron ore deposits is that Yampi Sound is a really magnificent, spacious, almost entirely land-locked deep-water harbour, which the largest ships in existence would be able to enter and leave at any time of the tide and with deep water close to the shores.

The iron deposits are sedimentary beds of dense micaceous hematite, and belong to a class of iron ore-bodies which constitute about two-thirds of the world's iron ore resources. Such deposits are usually very uniform in size and value over large areas, and are interbedded between strata of aqueous deposition in the same manner as coal seams. The country stratification near Yampi Sound is seen to be much folded and crumpled, and the iron beds will no doubt show the same feature as they are developed below the surface. The beds are of great size, especially the two which appear on the south sides of Cockatoo and Koolan Islands. That on Cockatoo Island has had all coverings stripped from its south side, and rises from the beach in dark cliffs to a height of about 300 ft. at an angle of 55°. At its west end, the horizontal measurement across the ore-body is 172 ft., equal to about 130 ft. at right angles to the dip. Further inland and parallel with this main deposit are another set of smaller iron ore beds, but these are not of such pure ore as in the main bed. The Koolan main ore-body is exposed from the beach to a height of over 400 ft. at Angus Cove, and rises at the Fantome trigonometrical station to 609 ft. above the sea. It is again exposed down to the water's edge at a deep mangrove inlet further east, and again forms dark steep cliffs on the north side of a deep inlet in the east end of the island. Near the trigonometrical station, the outcrop measures 130 to 146 ft. across, apparently all good ore. A good deal of quartzite covering lies upon the ore-body between Angus Cove and the mangrove inlet, but would not interfere for a long time with the ready quarrying of ore without removal of overburden. The Koolan main deposit has a general southerly dip of about 55°, but has been folded over at the east end. Toward the north side of Koolan Island there are two other large ore beds, containing great quantities of excellent ore.

The report estimates the quantity of ore in the two islands, quarryable above high-water mark, at 97,300,000 tons, but points out that if probable ore in the portions of the beds below sea level be taken into account, this estimate would have to be increased several hundred-fold, making the occurrence one of the great iron ore deposits of the world. It is pointed out that the combination of a huge iron ore deposit of first-rate quality and workable by quarrying, with a first-class deep water harbour where ships can be loaded directly from the quarries, is almost unique, and is most favourable for cheap shipment. These advantages should go far to compensate for the cost of the long voyage to the British markets. It is pointed out, also, that there is a great likelihood that large quantities of alluvial ore can be dredged from the harbour near the foot of the iron cliffs.

The analyses show the ore to be mostly of great and unusual purity and free from deleterious ingredients, both phosphorus and sulphur being well within the limits expected from the world's best iron ores.

The report recommends that as much iron ore as possible should be sent to the Eastern States of Australia to be smelted there, as no coal suitable for blast-furnace iron smelting has yet been found in West Australia, and that coal be carried back to Yampi Sound as back-loading and stored there to make a coaling depot for vessels coming for cargoes of iron ore for the United Kingdom. It is shown that the working of the deposits must be carried on upon a large scale to be profitable, and that a strong combination of iron-smelting and shipping interests in Great Britain would be the most likely to be able to handle it to advantage. The coaling station at Yampi Sound would be of much value for naval purposes, and also for the general shipping of Indo-Chinese seas. Should the Navigation Act be applied to the north-west coast, this new harbour would be excellently situated for the transfer from inter-ocean shipping to the Australian coastal services.

The mineral leases on the island are held by Mr. John Thomson, of Claremont, under the ordinary terms of the Mining Act, 1904, but the report suggests that special legislation may be advisable to enable the deposits to be worked to best advantage and to secure the large capital necessary for this purpose. It is evident that in these enormous iron ore deposits West Australia has an asset of very great importance, likely to lead to great developments of the north-west country, and of great value not only to Australia but also to the British Empire.

[A cable message published in the Magazine last month announced that these iron ore deposits had been acquired by the Queensland Government.—EDITOR.]

MOLYBDENITE MINING IN AUSTRALIA.—An announcement by the Prime Minister early last month that the contract between the Australian and British Governments for the purchase by the latter of tungsten and molybdenite ores would remain in force until March 31, gave new heart to those engaged in the production of those metals, and further encouragement was afforded when he added that if the producers so desired he would be glad to offer the services of the Commonwealth to assist them in finding fresh markets for their output when the present contract expired. The output of molybdenite has increased greatly during the last two or three years, particularly in New South Wales, but also in Queensland, though in the latter State there was something of a decline in 1918. It is practically impossible to ascertain how much is won by men in small parties and how much by registered companies. One thing is, however, pretty certain. Had the price paid by the British Government been seriously reduced the effect would have been disastrous to several companies which are approaching the productive stage, or have not far passed into it.

One of the most promising properties in New South Wales was the Mammoth, at Yetholme, near Bathurst. The company was formed at a time when the Federal Treasurer refused to permit of the capital being raised in the Commonwealth, and, in consequence, registration was effected in New Zealand, although a good deal of Australian money found its way there for shares. After many months of working the company suddenly stopped, and is now in course of reconstruction. The fact that the Broken Hill Proprietary has renewed its option over a portion of the property is naturally regarded as a favourable indication, and there are well-informed people who have ventured to think that the big company will take over the whole concern. No authentic reason exists, however, for that supposition.

Another very promising mine in New South Wales is the Mount Booralong Molybdenite Mines, at Sandy Creek, Baldersleigh, which started with a capital (since increased) of £150,000 and was officially "opened" last May, when the machinery was set going. New rolls are about to be added to the mill plant, but it is expected that, without waiting for this addition, active production on a commercial scale will commence immediately. The ore is very rich in foliated mineral. It is expected to recover 98% of its contents, and that operations will pay well even should the price of the mineral drop.

In Victoria there is the Standard Molybdenite Company, at Everton, in the Beechworth district, whose ore carried the mineral in finely granulated form through the stone. The property is well equipped, the oil-flotation being installed for its recovery. On the advice of Minerals Separation some slight additions are being made preparatory to making a general start. The manager points with some pride to the fact that from ore which had to be cleared away before actual mining could be commenced they had up to last April won mineral which returned them over £2,000, and that in November their concentrate returned £33. 8s. per ton for gold content. A few weeks ago the Bright correspondent of the *Industrial Australian & Mining Standard*, a man of large experience in the district, wrote: "Prospects of the Standard Molybdenite mine, at Everton, continue extremely promising, and increased interest in the mine is expected shortly. The plant for treating the ore at the mine is now practically completed, and will be started at an early date, several delays having occurred through waiting for materials. Two parcels of ore sent to Melbourne last month have turned out as well as was expected, and indicate how good are the prospects of the future. One parcel of 8 tons 4 cwt. assayed 10·95% and was sold for over £310 net, and a second lot of 12 tons 4 cwt. assayed 9·4%, and returned £400 net."

Among the scheelite producers the most conspicuous in the Commonwealth is the King Island Scheelite Company, which, as the island is politically a part of Tasmania, increased the status of that island with respect to this very considerably. The company was promoted by the Broken Hill Proprietary Block 14 Company; the company itself holds a very large interest and many of its shareholders have considerable private interests also. It is difficult to get reliable and up-to-date figures of production; but the significance of the King Island company is shown by the following comparison: New South Wales (hitherto the heaviest producer of scheelite) in 1916 yielded 81 tons; in 1917 the output was 127 tons; in 1918 it had dropped to 117 tons. Tasmania produced none in 1916; 69 tons in 1917; and in 1918 this had been increased to 216 tons.

MELBOURNE UNIVERSITY REFORM.—Several years ago an agitation was started for "popularizing" the Melbourne University. It commenced with men who had no knowledge of what a University was, or should be, beyond the fact that it was a means of education outside the ken of the ordinary man, and the gateway to professions which they were never tired of ragging. The fact that they catered for the wants of a privileged class eclipsed every other consideration, for in this "democratic" country there must be no "privileged class." Jack is as good as his master, and not a few would go so far as to add, "and sometimes a good deal better." It must be admitted, however, that of recent years there has been a very marked advance in the attention given to the necessity of technical education; the demand for technical schools in most of our important towns has been one of the most hopeful signs for a number of years. And there can be no doubt that a more modern constitution was necessary for the Melbourne University, as for many others. The method of reform, and its extent, became live questions, and eventually the governing bodies of the institution were asked to formulate a general scheme for giving effect to the popular wish without doing unnecessary violence to the existing system, and without lowering the standard of education which it had been instituted to maintain. The upshot was that the other day the Minister of Education, Mr. Hutchinson, introduced in the Legislative Assembly a Bill to reconstitute the controlling powers of the University, as well as to enlarge the Government's subsidy. In his second reading exposition of the Bill, the Minister said that since 1910 the University had made a marvellous growth. In 1904 there were 646 students and the annual endowment was £9,000. At that date the endowment was increased to £21,000 per annum for ten years, and that amount had been paid each subsequent year by annual votes in the House. The number of students had increased from 646 to 1,900, and this had resulted in great congestion in the class-rooms, indicating the imperative need for extended accommodation. The Bill he put forward proposed to increase and perpetuate the endowment, to provide a special grant for extensions, and to reform very materially the constitution of the University. The Cabinet felt that, as a considerable part of the revenue of the University was drawn from the consolidated revenue of the State, it was necessary to popularize its constitution. Up to 1904 the senior graduates controlled the management. They elected the council which, with the senate, made the two houses of government. After the endowment was increased by Sir Thomas Bent, three members of Parliament were added. It was now proposed to abolish the senate, as a legislative body, and the new council would be increased from 20 to 30. The Bill provided for the establishment of a convocation, consisting of all graduates who registered themselves for that purpose, members of the council, members of the professorial board, members of any of the faculties, or officers declared to be superior officers of the University. Of the council of thirty the Governor-in-Council would appoint seven, of whom one would be a member of the Legislative Council, two members of the Legislative Assembly, one representative of manufacturing and commercial interests, one representing agricultural interests, and two representing industrial interests. Twelve members would be elected by the convocation, and would not include any professor, associate professor, salaried full-time officer of the University, or head of an affiliated college. One member would be elected by the professors and associate professors, one member (being a salaried full-time officer, but not a professor or associate professor) would be elected by the teaching staff of the University, as apart from the professors; one member (a graduate of not less than three years' standing) would be elected by the undergraduates. The director of education and the president of the professorial board would be members of the council ex-officio, and six members would be elected by the members of the council already mentioned, and of the six, two (and not more than two) should be heads of affiliated colleges. Members of the council would ordinarily hold office for four years, though at the outset one-half of the first council would retire at the end of two years, as determined by the council. It was proposed to increase the annual endowment to £30,000. Although the committee of inquiry had recommended the appointment of a resident director or principal, the Ministry proposed to substitute an executive committee of three to be selected from the council, who will receive a sitting fee of 42s., provided that none receives more than £100 in one year. The extra £7,000 in the Government grant would be on certain conditions, namely, the creation of a school of commerce, and of tutorial and correspondence classes, as well as the teaching of applied science.

CAMBORNE.

HIGHER WAGE DEMAND.—The past few weeks have been fraught with the possibilities of a general strike of the employees of the mines over the demand for higher wages, as referred to in the last issue. Fortunately the young hot-heads have not succeeded, and the majority of the older men have had the good sense to see that the companies as a whole were really not in a position to grant the demand made. This truth is well illustrated by the recently published accounts of some of the leading concerns referred to later in this news letter. The storm centre was St. Just, where the majority of the workers belong to the Dockers' Union. Here, in the first instance, it was decided on a ballot, by 533 to 57, to turn down the terms offered by the employers, and to give notice to "down tools." Very properly, the employers decided to stand together with one regrettable exception. Though one or two of the richer mines might manage with difficulty to meet the demands made, it was quite out of the question for the poorer concerns such as Dolcoath, Grenville, and Tincroft to do so, and the alternative for them was closure. It appears that in the St. Just district the rates of pay have hitherto been somewhat higher than in the Camborne district, and the final offer of the Mines Federation led to a misunderstanding that in certain cases the rate of pay would in future be rather less than had hitherto been paid. However, it was subsequently made clear that no existing rate would be cut, and, with this assurance, the St. Just men decided to carry on. As regards the Camborne district, the ballot of the men resulted in the substantial majority of 1,018 out of 1,542 in favour of accepting the 15 to 20% advance offered by the Federation. In no case will an efficient man receive less than 45s. per week. It is obvious that this minimum is low enough under existing conditions. This the employers recognize, and if matters improve, as is hoped and indeed anticipated, a further increase may reasonably be looked for. Contracting will be encouraged, so that the miners may earn the highest rate of pay that they are capable of securing, and it is to be hoped that the men will do their share to secure improved results by increased output.

EAST POOL & AGAR.—Truly comparisons are sometimes odious, and to compare the profit of £103,784 earned by this company in 1918 with £5,522 in 1919 is certainly enough to make the shareholder, who only superficially examines the statement, anxious to sell his shares. What are the causes attributed by the management for this very considerable falling off in the production of profit-earning capacity of Cornwall's premier mine? First and foremost (although curiously enough no special reference is made to it) is the falling off in the price realized for the company's products, as is clearly shown in the figures given later, and secondly the reduction of tonnage handled due to neglected development, and also difficulties in coping with the heavy water influx in the lower levels. As regards the prices of the company's products, these substantially improved in the last few months of the year, and doubtless the average for the current year will show a distinct improvement. The development was neglected in 1918 because, owing to national requirements, all the underground labour force had to be concentrated on ore production, while last year the development work in the main was not of an exploratory nature, but rather opening up ore to meet immediate stoping requirements. It is satisfactory to note that main development work has been resumed, and that the now famous Rogers lode is to be tested at a deeper level, namely, at the 252 fm. level, while two other important main drives west on this lode are already being pushed with vigour. The water troubles have been most vexatious and have only been mastered by perseverance and the expenditure of a large sum of money. Early in 1919, as a result of the exceptionally heavy winter rainfall, the incoming water substantially increased, and this, coupled with several breakages to the Agar Cornish pump, resulted in the flooding of the 240 fm. level, where some of the most productive stopes were located. The installation of electric pumps to supplement the Cornish pumping plant eventually enabled the incoming water to be mastered late in the summer, and the position is now secure.

It will be noted that the total working cost shows but little increase, approximately only 2d. per ton, but this in the main is because in 1919 no Excess Profits Duty is payable as was the case in the previous year. Subject to this, actually all departments show substantial increases, particularly noteworthy being the higher pumping cost, which is up £17,538, or say 6s. per ton milled. Indeed the cost of pumping now exceeds the cost of breaking ground and tramming the ore to the shaft! The following comparative figures will be of interest:

		1918.	1919.
Tons Milled		75,401	65,895
Mineral Recovered:			
Black Tin	Tons	1,280	1,005
	Value	£249,544	£138,150
	Per ton	194·9	137·5
	Yield per ton (lb.)	38·03	34·15
Wolfram	Tons	57	72
	Value	£10,237	£5,502
	Per ton	178·5	76·5
	Yield per ton (lb.)	1·7	2·4
Arsenic	Tons	420	589
	Value	£30,495	£21,892
	Per Ton	72·6	37·19
	Yield per ton (lb.)	12·4	20

Working costs per ton:	1918. s.	d.	1919. s.	d.
Development	7	4·08	5	0·05
Ore Extraction	16	9·20	25	3·53
Treatment	11	5·23	14	11·37
General Expenses	15	1·78*	5	7·20
	50	8·29	50	10·15

* Includes about 8s. per ton for Excess Profits Duty.

The development footage was 3,874 ft. as compared with 4,215 ft. in 1918, and no diamond-drilling appears to have been carried out last year. The actual extraction also shows a slight falling off. No reference is made in the report to several features on which many besides shareholders are looking for information, such as the progress made with the tin flotation experiments, the new arsenic plant, and the changed method in the sale of the company's tin concentrate from the Ticketing to private contract, but doubtless Mr. Moreing will dilate on these in his speech at the annual meeting. The financial condition of the company is particularly strong, the realizable assets figuring at no less than £168,213, and we have little doubt that in the current year there will be a resumption of dividends.

Dolcoath.—It is a long time since we have read such a colourless report as the one of this company recently issued for the six months ended December 31 last; evidently the management is marking time pending any action the Government may take on the recommendations of the Non-Ferrous Mines Committee. If financial help of any kind is expected, we fear the directors will be disappointed, and frankly we are surprised that they should be content to wait on any such anticipation, and not attempt to work out their own salvation. It is quite evident that the company is in a tight corner, largely through circumstances beyond the control of the management, but the "wait and see" policy will not help to solve the problem. More capital is needed so that a vigorous policy of exploratory development may be at once instituted, otherwise the end is in sight. We believe there are people willing to find such capital, of course probably on terms not too favourable to the present proprietors. However, to get back to the report, the loss for the period under review was £19,699, without any provision for depreciation, and this compares with a loss of £19,510 for the previous six months. The loss may be attributed to increased costs and a falling ore content, but these factors have been partly offset by a higher price for tin. The comparative figures given below clearly illustrate this:

	Six months ended June 30, 1919.	Six months ended Dec. 31, 1919.
Tons of ore milled	28,877	32,826
Black tin produced, tons	387	345
Produce per ton milled	30·05	23·55
Average price per ton black tin	[illegible]	[illegible]
Total receipts per ton of ore milled	33s. 3d.	36s. 0¾d.
Total cost per ton of ore milled	46s. 9¼d.	47s. 0¾d.

The development was 743 ft. as compared with a footage of 460 for the previous six months, but, as the managing director properly points out, it is greatly disproportionate to the output. The Stray Park exploratory work at the 338 and 352 fm. levels appears to have been discontinued; at any rate no reference is made to it in the report.

The eastern stamps and dressing floors have been stopped and all the mine output is now conveyed by electric haulage to the western battery of twelve heads of pneumatic stamps. This centralization, it is anticipated, will both reduce costs and secure higher efficiency.

Levant.—The final statement of account of the old cost-book company, covering the period from August 23 to December 31, 1919, shows a loss of £5,560. During this period, 3,908 tons of ore was crushed, and the sales of black tin amounted to 86 tons, and arsenic 58 tons. A good many shareholders are wondering why nothing has recently been heard of the new company.

PERSONAL

W. BARNES is visiting Spain for Messrs. Ruston & Hornsby, Ltd.

EDWIN S. BERRY, of the firm of Yeatman & Berry, has returned to New York on the completion of his examination of the Mount Elliott mines, North Queensland.

GEORGE BOTTOMS left for Nigeria on March 28.

L. VENN BROWN has resigned as manager for the King Island Scheelite Co., Tasmania, and has started practice as consulting engineer at Sydney.

JOHN M. CAIRNS has gone to Spain.

HENRY F. COLLINS has gone to Spain.

H. J. DALY has joined the board of Hampton Properties, Ltd.

T. A. DAVIDSON has gone to the Toro company's properties in Nigeria.

E. H. DAVISON has been elected president of the Cornish Institute of Engineers for the coming year.

D. M. DEANE, metallurgist to the Talisman Consolidated, has left for Melbourne, and will make a tour of the world.

A. E. DRUCKER has been appointed professor of metallurgy in the Wisconsin State School of Mines.

A. H. FLOWERDEW has left the firm of J. A. Russell & Co., and has started practice as consulting mining engineer at Kuala Lumpur, Federated Malay States.

COLIN FRASER, a director of the Broken Hill Associated Smelters, is taking a holiday in New Zealand.

MAURICE GREGORY has presented a collection of Brazilian minerals to the Camborne School of Mines.

R. T. HANCOCK is home from Nigeria.

A. HIBBERT is mine manager for the Cyprus Mines Corporation.

HARLEY E. HOOPER has returned to the Kanbauk mine, Burma, on the conclusion of a visit to Australia.

H. F. HUESTON is expected from Nigeria.

JOHN M. ILES is expected from Australia.

GUSTAV IMROTH is here from Johannesburg.

H. H. KING, recently appointed alluvial manager for the Calloose company, has resigned.

G. C. KLUG has made a report on the Tasman and Crown Lyell Extended mine, Tasmania.

NEWTON BOOTH KNOX has returned to Spain.

DR. MALCOLM MACLAREN is back from Algeria.

C. H. MACNUTT is now manager for the Black Lake Asbestos & Chrome Co., Quebec.

WILLIAM MCNEILL has gone to Nigeria.

S. C. MAGENNIS has returned from Burma.

E. MAXWELL-LEFROY and A. W. ROSS are superintendents with the Burma Finance & Mining Co., Ltd., the Indian company recently formed to acquire the Burma wolfram interests of the Burma Queensland Corporation.

M. L. PATTERSON was in London last month on his way from Burma to the United States.

WALTER G. PERKINS is here from the United States.

R. W. PICKEN is returning from Nigeria in May.

E. DAVID POPE has returned from Chile.

WALLINGTON A. POPE has returned from Nigeria.

F. DANVERS POWER has been inspecting the Mount Barney molybdenite deposits, New South Wales.

R. P. ROBERTS, chief metallurgist to the Mount Lyell Company, is visiting America.

JOHN SMEDDLE has left Oatman, Arizona, for Guanajuato, Mexico.

E. GIBBON SPILSBURY has returned to New York from Brazil.

A. E. STRICK, metallurgist at Mount Elliott, is visiting the United States.

OLIVER THOMPSON has left on his return to Nigeria.

MAJOR H. WHITTINGHAM has resigned as manager of the Gennamari mines, Sardinia, and is taking a holiday in England.

ROBERT WILLIAMS has been decorated by the King of the Belgians with the Cross of "Commandeur de l'Ordre Royal du Lion," in recognition of his services rendered in connection with the industrial development of the Congo State.

O. H. WOODWARD, of Mount Morgan, has joined the metallurgical staff of the Broken Hill Associated Smelters.

EDWARD POPE, an engineer well known in this country in connection with Australian mines, died early this year shortly after his arrival in West Australia.

J. S. MACARTHUR, the inventor of the cyanide process, died at Glasgow on March 16. During the last few years he devoted his attention to the production of radium salts.

CHARLES LAPWORTH, professor of geology in the Birmingham University, died last month at the age of 78. He was an authority on the geology of the Midlands, Wales, and South Scotland.

JAMES GAYLEY, one of the metallurgists of the United States Steel Corporation, died on February 25. He was president of the American Institute of Mining Engineers in 1904. He will be best remembered for his work in connection with the drying of the air used in blast-furnaces.

F. W. LINCK died of pneumonia last month in London. He was born in New Zealand and educated at the Thames School of Mines. For some years he was engaged in mining in New Zealand, and afterwards went to West Australia. In 1904 he went to the Guianas, and in 1907 to the Urals, where he was engaged in platinum and gold mining. Subsequently he was in Cornwall and in Montana. More recently he was in Burma as manager of the Hermyngyi wolfram mine for Tavoy Concessions, Ltd.

HENNEN JENNINGS died at Washington on March 5. He was one of the American engineers associated with the Rand in early days and eventually became consulting engineer to Wernher, Beit & Co., in London. He served two terms as president of the Institution of Mining and Metallurgy, and during that time did much to help the cause of mining education at South Kensington. We quote herewith Mr. T. A. Rickard's tribute to his memory: "He was born at Hawesville, Kentucky, in 1854, and graduated from the Lawrence Scientific School at Harvard in 1877. After graduation he came to California and became associated with Hamilton Smith, H. C. Perkins, and Ross E. Browne. He was engineer successively at the North Bloomfield and New Almaden mines in California. In 1886 he married the daughter of John C. Coleman, one of the two brothers who owned the Idaho mine at Grass Valley. A year later he went to Venezuela as manager of the El Callao mine, remaining there two years. In 1889 he went to the Rand, as engineer to Jules Porges & Co., the predecessors of Wernher, Beit & Co. He became consulting engineer to the firm, retaining this important position until his retirement in 1905, spending the last seven years in London, where he was a recognized leader of the profession. In 1903 he was elected president of the Institution of Mining and Metallurgy; in 1904 he was re-elected and also received the gold medal of the Institution in recognition of his efforts in behalf of technical education. On his return to the United States in 1905 he settled at Washington and served as consulting engineer to the Conrey Placer Co. in Montana, an enterprise in which, through a bequest, Harvard had acquired a large financial interest.

In later years he was consulting mining engineer to the U.S. Bureau of Mines and in 1918 he undertook an investigation of the gold-mining industry. His career was long, useful, and full of honour. A man of keen public spirit, he took a leading part in the efforts to promote technical education in South Africa, England, and the United States; he gave his help to the betterment of the profession and to the welfare of all those engaged in mining. A man of cautious, rather than of brilliant, mind, he proved a sagacious adviser to the financial house identified with the biggest operations known to the modern world. He was loved by many and respected by all. To his son he leaves an honourable tradition and to his friends a happy memory."

TRADE PARAGRAPHS

THE CLIMAX MOLYBDENUM CO., of 61, Broadway, New York, have published a book on commercial molybdenum steels.

LOW & BONAR, LTD., of Dundee, send us graphic charts showing the monthly movements of prices of raw jute and hessian cloth.

H. C. SLINGSBY, of 142, Old Street, London, E.C., sends us a catalogue of extensible and interchangeable ladders.

VIVIAN, YOUNGER, & BOND, of 7, Gracechurch Street, London, E.C.4, have published a chart showing the monthly prices of metals during the last twenty years.

THE HARDINGE CONICAL MILL CO., of Denver, New York, and London, send us a pamphlet demonstrating the ease with which their mill is transported under the most difficult conditions.

JOHN & EDWIN WRIGHT, LTD., of the Universe Works, Birmingham, have sent us a handsome wall calendar covering the years 1920 to 1923. They had a representative show of their steel, manila, and hemp ropes at the recent exhibition at the Agricultural Hall, London, and are now well represented at the International Building Trades Exhibition at Olympia.

THE DENVER ROCK-DRILL MANUFACTURING CO., of Denver, U.S.A., publish a monthly periodical called *Keepintouch*. This paper deals primarily with the Waugh drill, but also gives a great deal of information relating to the technique of drilling and mining generally. It also contains much of personal interest relating to the "Waugh family," which is evidently a happy as well as an efficient one.

The March issue of the *Edgar Allen News*, published by EDGAR ALLEN & CO., LTD., Imperial Steel Works, Sheffield, contains a number of articles of interest to mining men. One of these relates to the use of manganese steel in the construction of dredger parts. Another gives particulars of the Holbeck system of powdered fuel for power purposes for which Edgar Allen & Co. make the plant. Particulars are also given of a big portland cement plant erected near Hull.

THE GENERAL ELECTRIC CO., LTD., of 67, Queen Victoria Street, London, E.C.4, Birmingham, Erith, and Hammersmith, have issued a revised edition of their Bulletin No. 1 relating to electrical plant. The descriptions and illustrations show the great number of applications for the electric drive nowadays. Among the many instances of interest to the mining man, one attracts special attention owing to its novelty. This is an electrically-operated dredge excavating peat, which is carried to its destination by pipe-line.

THE SULLIVAN MACHINERY CO., of Chicago, and Salisbury House, London, E.C.2, have issued a number of new bulletins relating respectively to: Tandem compound Corliss air-compressors, Class WC; Water Hammer-Drill DX 61; Belted and motor-driven air-compressors WG6, WH6, and WK6; Utility forge hammer operated by compressed air or steam; Valveless stoping drills, DT44; Portable air-compressors driven by petrol engine WK31; Angle-compound power-driven air-compressors, belted or direct-connected, WJ3, WJ4, WN3, and WN4; WA6 air compressor, straight-line type with simple steam and air cylinders and wafer air valves; Drill-steel furnace for oil or gas fuel.

METAL MARKETS

COPPER.—The general tendency of this market, so far as this country is concerned, has been toward easier prices during the month of March. In the meanwhile little movement has been seen in prices in America, which have fluctuated round 18½ to 19 cents. The decline on this side therefore must be largely put down to the improving rate of the dollar exchange which has naturally reduced the cost of importing electrolytic from America. The standard market has to a certain extent fluctuated in sympathy with refined, although other outside considerations have also affected this market. At one time sentiment in regard to metal markets generally took a rather less favourable turn, and considerable liquidation was seen in all the markets. This naturally had an adverse effect upon standard. The change in sentiment referred to was no doubt overdue, the markets having for such a long time seen continually rising prices. Therefore the situation should be all the healthier for the reaction. Business in refined copper in this country has not been very important during the period under review. This may to a certain extent still be attributed to the quantities of scrap which have been available. An important contributory cause is no doubt the reduced output of works here owing to difficulties in procuring fuel, etc. This is illustrated by some of the large cable makers buying wire rods, and indeed wire itself, for part of their requirements, instead of drawing the wire from the raw material. The American situation has not shown very much change. One of the most important features there has been the proposal to form a Copper Finance Corporation, which proposal it is understood is now taking tangible shape. The exact object of this concern is not quite clearly understood here, but it is believed that the idea is to grant credit facilities to European buyers with the object of encouraging business in American copper. Immediately the announcement in regard to this new corporation was made, the market in America took a rather firm turn, due to the buying by domestic consumers, who apparently anticipated an upward movement in price as a result of the increased export business which might become possible by reason of the credits it was proposed to grant. As regards output in the United States, it is understood to be running at something like 60% of capacity, and it seems clear that prices would have to advance above their present level before producers would consider it worth while coming up to anything like full output. As regards the existing surplus stock, there is considerable conjecture as to their present extent, but it is generally believed they have been considerably reduced.

Average prices of cash standard copper: March 1920, £109. 11s. 11d.; February 1920, £120. 6s. 2d.; March 1919, £76. 17s. 7d.; February 1919, £78. 10s. 3d.

TIN.—Although this market had a strong tone at the beginning of the month and prices ruled well over £400 per ton, a very considerable decline has since been seen when the price of cash tin went as low as about £333 per ton. Since then, however, rather a better tone has been in evidence, and prices recovered to a considerable

Daily London Metal Prices: Official Closing
Copper, Lead, Zinc, and Tin per Long

	Copper				
	Standard Cash	Standard (3 mos.)	Electrolytic Ingots	Electrolytic Wire-Bars	Best Selected
March	£ s. d. £ s. d.	£ s. d. £ s. d	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
10	110 15 0 to 111 0 0	113 15 0 to 114 0 0	118 0 0 to 122 0 0	118 0 0 to 122 0 0	119 0 0 to 121 0 0
11	108 5 0 to 108 10 0	111 10 0 to 111 15 0	115 0 0 to 120 0 0	115 0 0 to 120 0 0	119 0 0 to 121 0 0
12	110 0 0 to 110 5 0	113 5 0 to 113 10 0	117 0 0 to 120 0 0	117 0 0 to 120 0 0	117 0 0 to 118 0 0
15	108 5 0 to 108 10 0	111 10 0 to 111 15 0	117 0 0 to 120 0 0	117 0 0 to 120 0 0	117 0 0 to 118 0 0
16	107 0 0 to 107 5 0	110 0 0 to 110 5 0	117 0 0 to 120 0 0	117 0 0 to 120 0 0	117 0 0 to 118 0 0
17	102 15 0 to 103 0 0	106 5 0 to 106 10 0	116 0 0 to 118 0 0	116 0 0 to 118 0 0	117 0 0 to 118 0 0
18	104 10 0 to 104 15 0	107 15 0 to 108 0 0	116 0 0 to 118 0 0	116 0 0 to 118 0 0	117 0 0 to 118 0 0
19	106 10 0 to 106 15 0	109 10 0 to 109 15 0	114 0 0 to 117 0 0	114 0 0 to 117 0 0	114 0 0 to 116 0 0
22	108 0 0 to 108 10 0	111 0 0 to 111 10 0	115 0 0 to 118 0 0	115 0 0 to 118 0 0	114 0 0 to 116 0 0
23	107 15 0 to 108 0 0	110 15 0 to 111 0 0	116 0 0 to 118 0 0	116 0 0 to 118 0 0	114 0 0 to 116 0 0
24	108 0 0 to 108 5 0	110 15 0 to 111 0 0	116 0 0 to 118 0 0	116 0 0 to 118 0 0	114 0 0 to 116 0 0
25	106 0 0 to 105 5 0	108 15 0 to 109 0 0	115 0 0 to 118 0 0	115 0 0 to 118 0 0	114 0 0 to 116 0 0
26	103 10 0 to 103 15 0	106 10 0 to 106 15 0	114 0 0 to 116 0 0	114 0 0 to 116 0 0	113 0 0 to 114 0 0
29	104 10 0 to 104 15 0	107 10 0 to 107 15 0	113 0 0 to 115 0 0	113 0 0 to 115 0 0	113 0 0 to 114 0 0
30	107 15 0 to 118 0 0	110 15 0 to 111 0 0	115 0 0 to 118 0 0	115 0 0 to 118 0 0	114 0 0 to 116 0 0
31	107 5 0 to 107 10 0	110 10 0 to 110 15 0	116 0 0 to 118 0 0	116 0 0 to 118 0 0	114 0 0 to 116 0 0
April					
1	108 0 0 to 108 5 0	111 0 0 to 111 5 0	116 0 0 to 118 0 0	116 0 0 to 118 0 0	115 0 0 to 117 0 0
6	105 10 0 to 105 15 0	108 7 6 to 108 10 0	114 0 0 to 117 0 0	114 0 0 to 117 0 0	114 0 0 to 115 0 0
7	105 0 0 to 105 5 0	108 0 0 to 108 5 0	113 0 0 to 115 0 0	113 0 0 to 115 0 0	114 0 0 to 115 0 0
8	102 10 0 to 102 15 0	105 5 0 to 105 10 0	112 0 0 to 114 0 0	112 0 0 to 114 0 0	114 0 0 to 115 0 0
9	100 15 0 to 101 0 0	103 15 0 to 104 0 0	111 0 0 to 113 0 0	111 0 0 to 113 0 0	110 0 0 to 112 0 0

extent, although on balance values are fully £50 per ton down on the month and prices declined again early in April. The main cause of the decline has been very free selling in the standard market by prominent interests, this selling it is generally understood being in connection with stocks of Dutch tin. At one time, owing to the rate of exchange, it was considered improbable that supplies of this tin would come to this country, but owing to an improving exchange, circumstances have altered and permitted of the selling referred to. It now looks as if some quantities of Banca or Billiton tin might eventually augment the existing stocks of tin in this country. In the meanwhile America abstained from buying in this market for a very long time, but when the lower level of prices was reached buyers in the United States began to display more interest, and quite a good business is believed to have been done here on American account. This indeed seems to have been largely responsible for the upward reaction which was subsequently seen in the market, although at the end of the month the tone became uncertain again. There seems no doubt that a large amount of the bull element cleared out of their holdings during the decline, being naturally nervous at seeing prices slipping away so rapidly. No doubt also bear sales were indulged in, and these factors materially assisted in the fall. Business with home consumers has been somewhat irregular, partly owing to the unsettled state of the market, and partly also owing to the steel strike which prevailed in South Wales for a time. This hampered deliveries of steel bars to the tinplate works, who consequently were less inclined to enter into commitments for fresh supplies of tin. With regard to China, it has been reported that the stocks there amounted to as much as 10,000 tons, but as a portion at least of this is believed to be under the control of banks there, it was considered that liquidation was improbable unless a considerable fall in the price of silver was seen. The Banca production during 1919 is put at 12,004 tons, against 12,378 tons in 1918, and 13,446 tons in 1917. The exports of tin from the Federated Malay States during February are given officially as 3,014 tons, against 2,664 tons last year.

Average prices of cash standard tin: March 1920, £369. 14s. 5d.; February 1920, £395. 16s. 6d.; March 1919, £236. 18s. 5d.; February 1919, £224. 3s. 5d.

Lead.—Like others this metal has seen a considerable decline in values during the past month, not that there has been any real change in fundamental conditions, but rather owing to a change of sentiment. At one time rumours were current that an almost immediate resumption of work at Broken Hill was possible, and although these subsequently proved to be unfounded, the report had already had the effect of causing some weakness in the market. On the top of this the Government here, who are of course the chief holders of the metal in this country, showed a disposition to press deliveries upon those who had purchased metal from them. As an outlet among the consuming trades did not appear to be immediately available, such metal had either to be stored or else liquidated, and the consequence was that the easier tone already apparent in the market became more accentuated, and prices dropped fairly steadily. At the lower level the market took rather a firmer turn again, but early in April prices again gave way upon more favourable reports as to the prospects of a resumption of work at Broken Hill. There seems no doubt, however, that the consumption has been considerably reduced by reason of the high prices, and it now remains to be seen whether the existing stocks of the metal will be sufficient to carry the trade along until operations are resumed at the Broken Hill mines, or until the United States, Mexico, or Spain are able to furnish supplies of lead for this market.

Average prices of soft pig lead: March 1920, £47. 1s. 10d.; February 1920, £50. 12s. 9d.; March 1919, £26. 16s. 11d.; February 1919, £26. 13s. 0d.

Spelter.—In common with the others the market for this metal has also seen easier conditions during the period under review. This seems mainly to be a result of the over-trading which was conducted in the article some months ago. At that time a very considerable amount of speculative interest was taken in this metal, such buying being satisfied by dealers who apparently simultaneously purchased in America. The metal so purchased has lately been coming forward in considerable quantities, and consumers being apparently for the moment sufficiently supplied, much liquidation was seen on the Metal Exchange which had the effect of considerably reducing prices. Values indeed

PRICES ON THE LONDON METAL EXCHANGE.
Tons; Silver per Standard Ounce; Gold per Fine Ounce.

Lead: Soft Foreign	Lead: English	Zinc (Spelter)	Standard Tin: Cash	Standard Tin: 3 mos.	[illegible]	Forward	Gold	
£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.			s. d	March
50 5 0 to 53 0 0	52 10 0	57 0 0 to 59 15 0	383 0 0 to 384 0 0	[illegible]	75	[illegible]	[illegible]	10
49 5 0 to 51 15 0	51 10 0	55 0 0 to [illegible] 0 0	[illegible] 10 0 to 388 0 0	392 10 0 to [illegible]	[illegible]	[illegible]	[illegible]	11
48 10 0 to 50 15 0	51 0 0	55 0 0 to 58 0 0	387 15 0 to 388 0 0	392 5 0 to 392 10 0	[illegible]	70½	[illegible] 1	12
47 12 6 to 49 15 0	50 0 0	54 0 0 to 57 0 0	[illegible] 5 0 to 383 10 0	[illegible] 15 0 to [illegible] 0 0	[illegible]	70½	112 [illegible]	[illegible]
45 0 0 to 47 0 0	47 10 0	53 0 0 to 54 15 0	371 10 0 to 372 0 0	376 10 0 to 377 0 0	[illegible]	[illegible]	111 6	16
42 10 0 to 44 10 0	45 10 0	51 0 0 to 53 0 0	358 0 0 to 358 10 0	363 0 0 to 363 10 0	[illegible]	66	110 0	[illegible]
44 10 0 to 47 0 0	47 10 0	52 5 0 to [illegible]	335 0 0 to 336 0 0	[illegible] 340 15 0 to 341 0 0	[illegible]	68½	110 2	[illegible]
46 0 0 to 48 5 0	49 0 0	54 10 0 to 56 10 0	353 0 0 to 354 0 0	[illegible] 358 10 0 to 359 0 0	[illegible]	[illegible]	108 [illegible]	19
45 0 0 to 47 5 0	48 0 0	53 0 0 to 55 10 0	354 10 0 to 355 0 0	[illegible] 15 0 to [illegible] 0	77	[illegible]	108 11	
44 10 0 to 46 10 0	47 10 0	52 5 0 to 54 10 0	345 0 0 to 346 0 0	348 [illegible] 0	[illegible]	75½	108 [illegible]	23
43 5 0 to 45 5 0	46 0 0	51 0 0 to 53 5 0	344 0 0 to 344 10 0	[illegible] 15 0 to 347 0 0	71[illegible]	[illegible]	108 [illegible]	[illegible]
40 0 0 to 42 0 0	43 0 0	48 10 0 to 51 0 0	332 10 0 to 333 0 0	335 5 0 to 335 10 0	[illegible]	[illegible]	107 [illegible]	25
40 5 0 to 41 15 0	43 0 0	48 10 0 to 51 0 0	338 0 0 to 338 10 0	339 10 0 to 340 0 0	[illegible]	71	105 8	26
40 5 0 to 41 15 0	43 0 0	49 5 0 to 51 15 0	345 0 0 to 345 10 0	[illegible] 5 0 to 346 15 0	[illegible]	[illegible]	105 [illegible]	29
41 0 0 to 43 0 0	43 10 0	50 0 0 to 52 15 0	359 0 0 to 359 5 0	[illegible] to 359 15 0	72½	[illegible]	[illegible] 7	30
43 0 0 to 45 0 0	45 0 0	50 0 0 to 53 0 0	348 0 0 to 348 10 0	[illegible] 0 to [illegible]	[illegible]	[illegible]	106 2	31
								April
42 15 0 to 44 15 0	45 0 0	49 0 0 to 52 5 0	351 10 0 to 352 0 0	351 10 0 to 352 0 0	72⅛	72¼	105 0	1
40 0 0 to 42 5 0	43 0 0	48 10 0 to 51 5 0	350 0 0 to 350 10 0	349 10 0 to 350 0 0	[illegible]	[illegible]	103 0	[illegible]
40 5 0 to 42 5 0	43 0 0	47 0 0 to 49 15 0	341 5 0 to 341 10 0	[illegible] 5 0 to 341 10 0	72⅛	71⅝	103 [illegible]	7
36 10 0 to 39 5 0	40 0 0	46 5 0 to 49 0 0	335 0 0 to 335 10 0	335 10 0 to [illegible] 0	[illegible]	71½	103 2	[illegible]
36 10 0 to 38 15 0	40 0 0	46 0 0 to 48 15 0	332 5 0 to 332 10 0	332 10 0 to 332 15 0	[illegible]	[illegible]	102 7	9

have been ruling at considerably less than what it would cost to produce the metal in this country, and it would even have been impossible to import the metal from America, which for the time being is the chief source of supply, at the prices at which it could be bought on the Metal Exchange. The stocks available on this side for prompt delivery have been fairly important, however, and until these and the speculative position generally is cleared up the outlook of the market is somewhat uncertain. In the meantime the chief producers in America did not show a disposition to follow the market downward, although they have since been less stiff in their prices. In some quarters it has been reported that production there has been increased lately, which is probably correct. Meanwhile consumers in this country have enjoyed active trade conditions, but have only been purchasing spasmodically owing to the unsettlement of the market.

Average prices of spelter: March 1920, £54. 16s. 8d.; February 1920, £62. 3s. 7d.; March 1919, £37. 10s. 3d.; February 1919, £42. 11s. 6d.

ZINC DUST.—There has been little change in this market, and high-grade imported material is quoted at £85 per ton.

ANTIMONY.—The market for this article has been steady, English regulus being still quoted at £72 per ton. Foreign material in warehouse here can be obtained around £67 per ton, although less money is asked by Eastern sellers for shipment to this country.

ARSENIC.—Dull but steady at £68 to £70 for white delivered London.

BISMUTH.—Ready demand, price steady at about 12s. 6d. per lb.

CADMIUM.—Moderate business moving at 6s. 6d. to 6s. 9d. per lb.

ALUMINIUM.—Firm at £165 for home consumption, but £185 quoted for export.

NICKEL.—£230 for the home trade and export.

COBALT METAL.—14s. per lb.

COBALT OXIDE.—10s. per lb. (black).

PLATINUM.—£26 nominal per oz.

PALLADIUM.—Nominal, subject to negotiation.

QUICKSILVER.—The market has been rather bare of spot supplies and although inquiry was not very brisk prices advanced to about £26. 10s.–£27 per bottle. Subsequently prices became easier on the stocks being replenished.

SELENIUM.—10s. to 11s. per lb.

TELLURIUM.—95s. to 100s. per lb.

SULPHATE OF COPPER.—Easier at about £46 to £47 per ton.

MANGANESE ORES.—Strong, 4s. upwards per unit c.i.f. U.K. for Indian grades. Position very acute owing to scarcity of supplies, and new business practically impossible.

TUNGSTEN ORES.—37s. 6d. per unit wolframite, 65%; scheelite, 65%, 34s. to 35s. per unit.

MOLYBDENITE.—Canadian quoted at about 100s. per unit c.i.f. for 85%.

SILVER.—At the beginning of March prices stood at 84d. for spot standard bars, but dropped to 65⅞d. in the middle of the month. Values then advanced again to 77d., but toward the end of the month declined once more to 72⅝d. per oz. At the time of writing (April 12), the quotation has fallen still fur ther, owing to sales from China and America, to 69d. cash and 67½d. forward.

GRAPHITE.—Quiet and easier; 80%, £32. 10s. to £37. 10s. per ton c.i.f. U.K.

CHROME ORES.—(48–50%), £10 per ton c.i.f. U.K.

IRON & STEEL.—These markets are still characterized by heavy demand and insufficient supplies, and owing to traffic difficulties and fuel scarcity it is difficult to increase output. Prices of Cleveland pig iron have been advanced to 212s. 6d. for No. 1 quality and 200s. for No. 3 Cleveland G.M.B. No. 4 Foundry and No. 4 Forge, with 5s. more for France, Italy, and Belgium. As regards hematite, the price of East Coast mixed numbers is firm at 260s. per ton with a premium of 5s. to 10s. per ton for export to the three countries named above. For exports to other overseas markets than those mentioned supplies of either Cleveland or hematite are practically unobtainable. If they could be had all sorts of fancy prices could be secured. With reference to steel, inquiries are numerous but actual business doing does not amount to much, makers being reluctant to quote, owing to their well-booked conditions, scarcity, and high cost of raw material, and difficulty in delivering stocks they have already got in hand.

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Par Value
	Oz.	Oz.	Oz.	£
January, 1919	662,205	13,854	676,059	2,871,718
February	621,188	15,540	636,728	2,704,647
March	694,825	17,554	712,379	3,025,992
April	676,702	18,242	694,944	2,951,936
May	706,158	18,837	724,995	3,079,583
June	682,603	19,776	702,379	2,983,515
July	705,523	19,974	725,497	3,081,713
August	686,717	19,952	706,669	3,001,739
September	[illegible]	18,199	698,558	2,967,287
October	705,313	18,409	723,722	3,074,174
November	657,845	20,125	677,920	2,879,834
December	631,833	18,358	650,191	2,761,836
Year 1919	8,111,271	218,820	8,330,091	35,383,974
January 1920	653,295	17,208	670,503	*
February	607,918	17,412	625,330	*

* Not given in the official returns.

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1919	160,599	11,848	3,539	175,986
February 28	172,359	11,868	4,264	188,491
March 31	175,620	11,168	5,080	191,868
April 30	175,267	11,906	5,742	192,915
May 31	173,376	12,232	5,939	191,547
June 30	172,505	12,544	5,831	190,880
July 31	173,613	12,453	5,736	191,802
August 31	170,844	12,450	5,655	188,949
September 30	169,120	12,392	5,294	186,806
October 31	167,499	12,691	4,492	184,682
November 30	164,671	12,565	4,337	181,573
December 31	166,155	12,750	4,271	183,176
January 31, 1920	176,390	12,766	4,796	193,952
February 29	185,185	12,708	5,217	203,110

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 65% of the working profit. Figures based on par value of gold.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1918	24,922,763	27 11	21 7	6 0	7,678,129
January, 1919	1,942,329	28 9	23 0	5 8	547,793
February	1,816,352	28 9	23 2	5 6	498,204
March	2,082,469	28 2	22 6	5 6	573,582
April	1,993,652	28 7	22 9	5 9	573,143
May	2,099,450	28 4	22 3	5 10	608,715
June	2,032,169	28 4	22 4	5 10	592,361
July	2,134,668	27 10	21 9	6 0	611,118
August	2,036,128	28 5	22 11	5 5	551,203
September	2,019,109	28 6	22 10	5 7	560,979
October	2,108,698	28 3	22 6	5 10	612,841
November	1,933,526	28 8	23 5	5 5	521,472
December	1,845,088	28 8	25 6	3 10	354,098
Year 1919	24,043,638	28 7	22 11	5 6	6,605,509

Production of Gold in Rhodesia and West Africa.

	Rhodesia. 1919	Rhodesia. 1920	West Africa. 1918	West Africa. 1919
	£	oz.	£	£
January	211,917	43,428	107,863	104,063
February	220,885	—	112,865	112,616
March	225,808		112,665	112,543
April	[illegible]	—	117,520	109,570
May	[illegible]	—	125,290	100,827
June	[illegible]	—	120,273	106,612
July	214,919	—	117,581	102,467
August	207,339	—	120,526	103,112
September	223,719	—	115,152	100,401
October	204,184	—	61,461	91,352
November	186,462	—	108,796	98,322
December	158,835		112,621	98,806
Total	2,499,498	43,428	1,333,553	1,240,691

Transvaal Gold Outputs.

	January. Treated	January. Yield	February. Treated	February. Yield
	Tons	£	Tons	Oz.
Aurora West	14,200	17,464	11,900	£15,466
Barrett	-	202 oz.	—	—
Brakpan	48,400	86,038	43,000	£80,463
City & Suburban	13,722	24,971	12,600	£16,913
City Deep	56,000	127,018	47,500	19,567
Cons. Langlaagte	43,500	63,977	32,300	£53,426
Cons. Main Reef	46,800	86,424	39,600	13,805
Crown Mines	176,000	281,271	170,000	51,494
Durban Roodepoort Deep	23,000	36,445	23,900	7,810
East Rand P.M.	125,000	178,219	106,000	29,827
Ferreira Deep	34,100	57,337	35,200	10,639
Geduld	45,000	89,029	42,000	15,172
Geldenhuis Deep	48,000	69,570	41,700	12,470
Glynn's Lydenburg	3,300	7,733	2,894	£5,540
Goch	15,400	14,385	14,000	£13,335
Government G.M. Areas	111,000	240,848	102,500	£231,088
Heriot	11,500	16,543	10,670	£16,206
Jupiter	22,600	28,651	21,000	4,794
Kleinfontein	50,200	79,276	47,500	£73,317
Knights Central	20,300	81,412	21,800	6,860
Knights Deep	88,800	81,412	88,700	16,469
Langlaagte Estate	35,650	50,916	24,700	£41,505
Luipaard's Vlei	17,160	18,961	18,100	£20,729
Meyer & Charlton	13,000	45,089	11,900	£43,151
Modderfontein	81,000	225,098	36,400	42,338
Modderfontein B	56,000	141,069	43,500	21,260
Modderfontein Deep	44,000	125,103	39,600	21,436
New Unified	11,000	15,768	8,900	£13,760
Nourse	42,000	7,044	34,700	12,637
Primrose	17,000	19,098	16,000	£18,795
Princess Estate	18,500	26,461	16,400	4,367
Randfontein Central	145,000	217,191	127,500	£192,714
Robinson	37,200	44,741	35,100	8,441
Robinson Deep	50,300	88,615	50,100	16,520
Roodepoort United	22,700	27,474	18,600	£22,829
Rose Deep	52,000	66,273	49,600	12,490
Simmer & Jack	46,100	58,503	46,100	11,326
Simmer Deep	45,800	54,766	45,500	10,150
Springs	40,500	75,968	33,900	£59,757
Sub Nigel	9,600	28,896	9,200	5,532
Transvaal G.M. Estates	16,480	32,873	15,760	£30,543
Van Ryn	34,600	45,691	34,530	£45,926
Van Ryn Deep	51,400	143,122	46,900	133,187
Village Deep	44,000	71,611	33,500	11,352
Village Main Reef	20,900	27,702	17,400	4,687
West Rand Consolidated	29,720	40,730	25,730	£39,117
Witwatersrand (Knights)	31,200	45,473	32,750	£48,154
Witwatersrand Deep	28,020	42,595	30,200	10,100
Wolhuter	29,800	45,284	29,700	8,208

West African Gold Outputs.

	January. Treated	January. Value	February. Treated	February. Value
	Tons	Oz.	Tons	Oz.
Abbontiakoon	6,647	£10,039	6,064	£10,940
Abosso	7,354	2,935	7,210	2,886
Ashanti Goldfields	6,069	6,967	2,413	3,438
Obbuassi	—	—	370	331
Prestea Block A	11,872	£20,067	10,887	18,966
Taquah	5,000	2,969	4,705	2,879

Rhodesian Gold Outputs.

	January. Treated	January. Value	February. Treated	February. Value
	Tons	£	Tons	£
Falcon	13,628	25,521*	14,026	22,513*
Gaika	2,851	4,767	3,134	5,044
Globe & Phœnix	5,239	10,929†	5,637	5,991†
London & Rhodesian	2,386	2,582	2,385	[illegible]
Lonely Reef	4,550	5,916†	4,300	5,544†
Rezende	5,000	10,148	5,500	2,350†
Rhodesia, Ltd.	—	—	671	496
Rhodesia, G.M. & I.	585	2,002	559	440†
Shamva	48,214	31,255	49,556	44,154
Transvaal & Rhodesian	1,750	4,417	1,700	4,374

* Gold, Silver and Copper; † Ounces Gold.

West Australian Gold Statistics.—Par Values.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
January, 1919	*	69,954	*	*
February	733	66,310	67,043	284,779
March	*nil*	66,158	66,158	281,120
April	33	63,465	63,498	269,720
May	525	68,655	69,180	293,856
June	1,050	73,546	74,596	316,862
July	680	68,028	68,708	292,852
August	835	58,117	58,952	250,410
September	†	†	†	†
October	586	64,987	65,573	278,535
November	1,171	64,823	65,994	280,323
December	831	27,334	28,165	162,575
January, 1920	836	25,670	26,505	112,590
February	1,928	49,453	51,381	218,251

* By direction of the Federal Government the export figures were not published. † Figures not received.

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1918	1919	1919	1920	1919	1920
	£	£	£	Oz.	£	£
January	32,134	36,238	37,100		18,000	28,000
February	58,113	46,955	43,330	7,200	24,000	15,000
March	65,412	40,267	48,000	—	16,000	—
April	29,620	63,818	61,200	—	24,000	—
May	87,885	37,456	38,200	—	16,000	—
June	45,765	41,465	44,600	—	17,000	—
July	64,347	37,395	42,060	—	22,000	—
August	61,163	51,564	49,700	—	20,000	—
September	65,751	76,340	37,120	—	13,000	—
October	*	39,018	36,100	—	28,000	—
November	*	40,735	32,720	—	51,000	—
December	70,674	63,311	44,500	—	31,000	—
Total	674,655	575,260	514,630	—	280,000	43,000

* Figures not received.

Australasian Gold Outputs.

	January.		February.	
	Treated Tons	Value £	Treated Tons	Value £
Associated	3,968	6,379	5,166	6,993
Associated Northern Blocks :				
Iron Duke	—	854*	—	631*
Victorious	—	352*	—	137*
Blackwater	1,700	2,922	2,413	4,071
Bullfinch	5,200	5,958	4,730	43,467
Golden Horseshoe	7,428	16,500	10,716	19,351
Great Boulder Prop.	6,222	18,061	9,474	27,577
Ivanhoe	10,042	2,700	14,218	5,400‖
Kalgurli	2,705	6,327	2,478	6,206
Lake View & Star	—	—	11,934	13,179A
Menzies Consolidated	—	—	1,560	3,111
Mount Boppy	—	—	—	—
Oroya Links	1,035	6,144†	1,548	7,529†
Progress	500	507	1,270	1,458
Sons of Gwalia	12,848	16,886	11,914	15,490
South Kalgurli	6,504	8,452	7,456	7,962
Talisman	—	—	—	—
Waihi	10,879	3,245‡	13,669	[illegible]
Waihi Grand Junction	—	—	3,540	1,110‡

* Surplus ; † Total receipts ; ‡ Oz. ; ‖ Profit ;
A Nov. 1 to Feb. 29.

Miscellaneous Gold Outputs.—Par Values.

	January.		February.	
	Treated Tons	Value £	Treated Tons	Value £
El Oro (Mexico)	—	—	29,259	249,000†
Esperanza (Mexico)	18,541	1,075§	18,160	1,998§
Frontino & Bolivia (C'lbia)	1,420	7,014	2,410	9,031
Mexico El Oro (Mexico)	—	—	11,800	222,640†
Nechi (Colombia)	166,475*	42,823	18,640*	6,464†
Oriental Cons. (Korea)	—	—	—	88,000†
Ouro Preto (Brazil)	7,400	17,049	7,000	2,453‖
Pato (Colombia)	119,367*	46,016†	70,425*	36,462†
Plymouth Cons. (Calif'rnia)	8,500	11,768	8,700	11,316
St. John del Rey (Brazil)	—	34,000	—	39,000
Santa Gertrudis (Mexico)	29,490	37,310	26,950	[illegible]

* Cubic yards. § Loss † Dollars. ‡ Profit, gold and silver. ‖ Oz.

Production of Gold in India.

	1916	1917	1918	1919	[illegible]
	oz.	oz.	oz.	oz.	oz.
January	45,214	[illegible]	41,420	38,184	39,073
February	43,121	42,566	40,787	36,834	38,572
March	43,702	44,617	41,719	38,317	[illegible]
April	44,797	43,726	41,504	38,248	
May	45,055	42,901	40,889	38,608	
June	44,842	42,924	41,264	[illegible]	
July	45,146	42,273	40,229	38,549	
August	45,361	42,591	40,496	37,850	
September	45,255	43,207	40,088	36,813	
October	45,061	43,041	39,472	[illegible]	
November	45,247	42,915	36,984	39,628	
December	48,276	44,883	40,149	42,643	
Total	541,077	520,362	485,236	451,171	[illegible]

Indian Gold Outputs.

	February.		March	
	Tons Treated	Fine Ounces	Tons Treated	Fine Ounces
Balaghat	3,050	2,107	3,200	[illegible]
Champion Reef	11,884	6,662	12,582	[illegible]
Hutti (Nizam's)	—	2,000	—	—
Mysore	19,624	13,323	20,852	[illegible]
North Anantapur	700	1,068	700	1,084
Nundydroog	8,093	6,176	8,708	6,306
Ooregum	12,800	7,536	12,600	7,602

Base Metal Outputs.

		Jan.	Feb.
Arizona Copper	Short tons copper	1,500	[illegible]
British Broken Hill	Tons lead conc.	—	—
	Tons zinc conc.	—	—
	Tons carbonate ore	—	—
Broken Hill Block 10	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Burma Corp.	Tons refined lead	1,706	1,810
	Oz. refined silver	205,830	226,720
Cordoba Copper		—	—
Fremantle Trading	Long tons lead	—	—
Hampden Cloncurry	Tons copper	—	585
North Broken Hill	Tons lead	—	—
	Oz. silver	—	—
Poderosa	Tons copper ore	550	529
Rhodesian Broken Hill	Tons lead	1,271	1,261
Tanganyika	Long tons copper	2,058	1,874
Tolima	Tons silver-lead conc.	—	45
Zinc Corp.	Tons zinc conc.	—	—
	Tons lead conc.	—	—

Imports of Ores, Metals, etc., into United Kingdom.

		Jan.	Feb.
Iron Ore	Tons	350,059	334,668
Manganese Ore	Tons	[illegible]	25,252
Copper and Iron Pyrites	Tons	28,852	29,236
Copper Ore, Matte, and Precipitate	Tons	1,317	4,806
Copper Metal	Tons	9,825	7,310
Tin Concentrate	Tons	4,285	1,506
Tin Metal	Tons	1,606	3,077
Lead, Pig and Sheet	Tons	5,888	8,598
Zinc (Spelter)	Tons	10,154	10,345
Quicksilver	Lb.	64,858	513,579
Zinc Oxide	Tons	3,117	597
White Lead	Cwt.	29,263	14,559
Barytes	Cwt.	37,132	23,658
Phosphate	Tons	48,850	20,743
Brimstone	Tons	790	337
Borax	Cwt.	—	40
Other Boron Compounds	Tons	3,204	1,977
Nitrate of Soda	Cwt.	163,542	193,440
Petroleum :			
Crude	Gallons	1,531,644	944,751
Lamp Oils	Gallons	11,817,994	12,189,032
Motor Spirit	Gallons	9,459,689	10,827,728
Lubricating Oils	Gallons	6,609,693	6,892,257
Gas Oil	Gallons	5,146,966	5,223,247
Fuel Oil	Gallons	22,787,549	17,985,677
Total Petroleum	Gallons	55,833,107	54,072,749

United States Metal Exports and Imports.

Exports.	Oct. Tons.	Nov. Tons.	Imports.	Oct. Tons.	Nov. Tons.
Copper Ingots	19,643	12,802	Antimony	1,083	251
Copper Tubes	350	197	Tin Con.	2,366	1,172
Copper Sheets	311	203	Tin	7,237	6,800
Copper Wire	1,835	1,464	Manganese Ore	15,863	11,694
Lead, Pig	3,721	2,511	TungstenCon	592	1,423
Zinc	9,650	5,009	Pyrites	67,155	40,259
Zinc Sheets	1,231	1,063			

Outputs of Tin Mining Companies.
In Tons of Concentrate.

	Year 1919 Tons	Jan. 1920 Tons	Feb. 1920 Tons
Nigeria:			
Abu	16	–	
Anglo-Continental	117	–	..
Associated Nigerian	185	20	–
Benue	71	4	4
Berrida	1	–	–
Bisichi	199	14	7
Bongwelli	52	3	4½
Dua	65	5	4⅛
Ex-Lands	260	30	30
Filani	25	3¼	3¼
Forum River	169	11	9
Gold Coast Consolidated	33	2	2¾
Gurum River	118	17	20
Jantar	118	12	16
Jos	193	13	15
Kaduna	189	21	20
Kaduna Prospectors	72	8	9
Kano	142	10	12½
Kassa-Ropp	84	–	–
Keffi	30	–	–
Kuru	266	17	9
Kuskie	13		–
Kwall	56	10	8
Lower Bisichi	78	7	6¾
Lucky Chance	27	1	2
Minna	38	8	3
Mongu	552	50	50
Naraguta	428	38	27
Naraguta Extended	276	17	15
New Lafon	125	–	–
Nigerian Tin	25	–	–
Ninghi	64	9	7
N.N. Bauchi	402	40	40
Offin River	50	19	–
Rayfield	618	40	40
Ropp	1,034	90	73
Rukuba	52	6	6½
South Bukeru	64	12	10
Sybu	27	1	⅝
Tin Areas	67	–	–
Tin Fields	148	5	6
Toro	3	–	–
Union & Rhodesian Trust	6	–	–
Federated Malay States:			
Chenderiang	264	–	–
Gopeng	797	60	60
Idris Hydraulic	244	26	23
Ipoh	169	14	11½
Kamunting	242	–	–
Kinta	438	36	37¼
Kledang	10	–	–
Lahat	463	30	32¾
Malayan Tin	605	53	44½
Pahang	2,180	173	195
Rambutan	180	24	21
Sungei Besi	413	32	31
Tekka	458	39	36
Tekka-Taiping	314	33	27
Tronoh	1,409	100	80
Cornwall:			
Dolcoath	554	–	–
East Pool	991	70	59
Geevor	417½	27	33½
Grenville	–	37	32¾
South Crofty	590	42	45¾
Other Countries:			
Aramayo Francke (Bolivia)	2,255	186	147
Berenguela (Bolivia)	–	33	29
Briseis (Tasmania)	190	12	15
Deebook (Siam)	306	18	13
Mawchi (Burma)	760	123	116
Porco (Bolivia)	283	–	26
Renong (Siam)	829	63	27
Rooiberg Minerals (Transvaal)	241	28	45
Siamese Tin (Siam)	743	115	114
Tongkah Harbour (Siam)	1,244	76	73
Zaaiplaats (Transvaal)	278	20	20

Nigerian Tin Production.

In long tons of concentrate of unspecified content.
Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1915 Tons	1916 Tons	1917 Tons	1918 Tons	1919 Tons	1920 Tons
January	417	531	667	678	613	547
February	358	528	646	668	623	461
March	418	547	655	707	606	—
April	444	486	555	584	546	—
May	357	536	509	525	483	—
June	373	510	473	492	484	—
July	455	506	479	545	481	—
August	438	498	551	571	616	—
September	442	535	538	520	561	—
October	511	584	578	491	625	—
November	467	679	621	472	536	—
December	533	654	655	518	511	
Total	5,213	6,594	6,927	6,771	6,685	1,008

Production of Tin in Federated Malay States.
Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1916 Tons	1917 Tons	1918 Tons	1919 Tons	1920 Tons
January	4,316	3,558	3,149	3,765	4,265
February	3,372	2,755	3,191	2,673	3,014
March	3,696	3,286	2,608	2,819	—
April	3,177	3,251	3,308	2,855	—
May	3,729	3,413	3,332	3,404	—
June	3,435	3,489	2,950	2,873	-
July	3,517	3,253	3,373	3,756	—
August	3,732	3,413	3,259	2,955	—
September	3,636	3,154	3,166	3,161	—
October	3,681	3,436	2,870	3,221	—
November	3,635	3,300	3,131	2,972	—
December	3,945	3,525	3,023	2,413	—
	43,871	39,833	37,370	36,867	7,279

Total Sales of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
July 14, 1919	145	£18,250	£125 17 3
July 28	122	£16,939	£138 16 11
August 11	127½	£17,125	£134 6 5
August 25	130½	£18,297	£140 4 3
September 8	115½	£16,588	£143 12 6
September 22	135½	£19,557	£144 6 9
October 8	72	£10,867	£150 18 7
October 20	32	£5,093	£159 3 2
November 3	34½	£5,235	£151 15 0
November 17	39	£6,161	£157 19 9
December 1	38	£5,905	£155 8 3
December 15	29	£5,133	£176 10 0
December 31	14¾	£2,884	£195 10 10
Total and Average, 1919	2,858	£366,569	£128 5 0
January 12, 1920	31	£6,243	£201 8 0
January 26	51¾	£10,574	£204 6 10
February 9	37½	£7,880	£210 2 8
February 23	53¾	£12,120	£225 10 0
March 8	18	£4,038	£224 7 7
March 22	44	£8,286	£188 6 8
April 6	44½	£8,367	£188 0 5

Details of Redruth Tin Ticketings.

	March 8 Tons Sold	March 8 Realized per ton £ s. d.	March 22 Tons Sold	March 22 Realized per ton £ s. d.
Tincroft Mines,	5	227 15 0	5	204 0 0
,, ,,	6	226 5 0	6	204 15 0
Penryn Minerals	–	—	1	170 0 0
,, ,,			9	1 5 0 0
,, ,,			9	186 0 0
,, ,,	–	—	3	176 15 0
,, ,,	–	—	5	157 12 6
Levant	7	220 7 6		—
Pendeen	–	—	3	194 0 0
Calloose	-	—	1	168 5 0
,,	-	—	2	230 5 0
Total	18		44	

STOCKS OF TIN
Reported by A. Strauss & Co. Long Tons.

	Feb. 29.	March 31.
	Tons	Tons
Straits and Australian Spot	1,023	1,431
Ditto, Landing and in Transit	1,783	1,306
Other Standard, Spot and Landing	1,303	1,225
Straits, Afloat	2,335	1,165
Australian, Afloat	248	332
Banca, in Holland	2,939	3,817
Ditto, Afloat	[illegible]	1,460
Billiton, Spot		
Billiton, Afloat	112	56
Straits, Spot in Holland and Hamburg		—
Ditto, Afloat to Continent	390	365
Total Afloat for United States	5,751	[illegible]
Stock in America	3,743	[illegible]
Total	[illegible]	18,279

SHIPMENTS, IMPORTS, SUPPLY, AND CONSUMPTION OF TIN.
Reported by A. Strauss & Co. Long tons.

	Feb.	March
Shipments from:	Tons	Tons
Straits to U.K.	2 030	820
Straits to America	2,390	1,585
Straits to Continent	390	390
Straits to Other Places	118	157
Australia to U.K.	250	250
U.K. to America	725	322
Imports of Bolivian Tin into Europe	2,309	1,403
Supply:		
Straits	4,810	2,795
Australian	250	250
Billiton	112	56
Banca	2,036	707
Standard	920	1,108
Total	8,128	4,916
Consumption:		
U.K. Deliveries	1,714	2,389
Dutch ,,	562	-
American ,,	5,200	5,195
Straits, Banca & Billiton, Continental Ports, etc.	160	525
Total	[illegible]	8,109

*Estimated.

DIVIDENDS DECLARED BY MINING COMPANIES.

Date	Company	Par Value of Shares	Amount of Dividend
March 24	Anaconda Copper	$50.	$1.
March 15	[illegible]	5s.	6d. less tax
March 31	Central Provinces Prospecting Synd.	£1.	1s. 7½d. + bonus 1s. 7½d. less tax
March 15	Cock's Pioneer	[illegible]	1s. less tax
March 26	Deebook Dredging	[illegible]	1s. less tax
March 22	Eldorado [illegible]	[illegible]	7s.*
March 17	Fanti Consolidated	8s.	1s. 3d. less tax
March 19	Ferreira Deep	£1.	2s. less tax
March 11	Gopeng Consolidated	£1.	9d. + 1s. bonus less tax
April 9	Idris Hydraulic Tin	[illegible]	1s. less tax
March 22	Ivanhoe	£5.	3s. less tax
March 25	Mason & Barry	£1.	2s. less tax
March 15	Mount Morgan	£1.	1s. less tax
April 7	Natal Steam Coal	£1.	2s. less tax
March 18	Nechi Mines (Colombia)	Pref. 10s	1s. 3d. less tax
March 26	New Jagersfontein	£1.	7s. 6d.
March 20	Nipissing Mines	$5.	25 cents less tax
March 30	Ooregum	10s. Pref & Ord.	1s. 6d. less tax
March 18	Pato Mines (Colombia)	£1.	7s. less tax
March 20	Plymouth Consolidated	[illegible]	1s. less tax
March 23	Rio Tinto	Ord. [illegible]	£1. less tax
March 31	Shamva	£1.	1s. 6d. less tax
April 7	Siamese Tin	£1.	4s. less tax
March 31	Tharsis Sulphur and Copper	£2.	5s. less tax
March 22	Transvaal G. M. Estates	£1.	1s. 6d.
March 11	Tronoh	£1.	1s. less tax
March 18	Tweefontein Colliery	Pref. £1 / Ord. £1.	9·6d. less tax / 9·6d. less tax

* First Liquidation Dividend

PRICES OF CHEMICALS. April 9.

		£	s.	d.
Alum	per ton	16	10	0
Alumina, Sulphate of	,,	16	10	0
Ammonia, Anhydrous	per lb.		2	0
,, 0·880 solution	per ton	37	10	0
,, Carbonate	per lb.			7½
,, Chloride of, grey	per ton	55	0	0
,, ,, ,, pure	per cwt.	5	5	0
,, Nitrate of	per ton	[illegible]	0	0
,, Phosphate of	,,	120	0	0
,, Sulphate of	,,	22	0	0
Antimony Sulphide, Golden	per lb.		1	3
Arsenic, White	per ton	72	0	0
Barium Sulphate	,,	12	0	0
Bisulphate of Carbon	,,	56	0	0
Bleaching Powder, 35% Cl.	,,	17	0	0
Borax	,,	41	0	0
Copper, Sulphate of	,,	[illegible]	0	0
Cyanide of Sodium, 100%	per lb.			11
Hydrofluoric Acid	,,			7½
Iodine	,,		16	0
Iron, Sulphate of	per ton	4	0	0
Lead, Acetate of, white	,,	97	0	0
,, Nitrate of	,,	70	0	0
,, Oxide of, Litharge	,,	71	0	0
,, White	,,	[illegible]	0	0
Lime, Acetate, brown	,,	19	0	0
,, ,, grey 80%	,,	[illegible]	0	0
Magnesite, Calcined	,,	22	0	0
Magnesium, Chloride	,,	17	0	0
,, Sulphate	,,	12	0	0
Methylated Spirit 64° Industrial	per gal.		5	7
Phosphoric Acid	per lb.		1	9
Potassium Bichromate	per lb.		[illegible]	[illegible]
,, Carbonate 85%	per ton	110	[illegible]	0
,, Chlorate	per lb.		1	0
,, Chloride 80%	per ton	25	0	[illegible]
,, Hydrate (Caustic) 90%	,,	[illegible]	0	[illegible]
,, Nitrate	,,	[illegible]	0	0
,, Permanganate	per lb.		[illegible]	[illegible]
,, Prussiate, Yellow	,,		[illegible]	[illegible]
,, Sulphate, 90%	per ton	[illegible]	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	59	0	0
,, Arsenate [illegible]	,,	[illegible]	0	0
,, Bicarbonate	,,	[illegible]	10	0
,, Bichromate	per lb.			
,, Carbonate (Soda Ash)	per ton	16	0	[illegible]
,, ,, (Crystals)	,,	5	10	[illegible]
,, Chlorate	per lb.			6
,, Hydrate, 76%	per ton	24	0	0
,, Hyposulphite	,,	[illegible]	10	0
,, Nitrate, 95%	,,	26	0	0
,, Phosphate	,,	[illegible]	0	0
,, Prussiate	per lb.		[illegible]	0
,, Silicate	per ton	12	0	[illegible]
,, Sulphate (Salt-cake)	,,	5	[illegible]	0
,, ,, (Glauber's Salts)	,,	[illegible]	0	0
,, Sulphide	,,	[illegible]	0	[illegible]
Sulphur, Roll	,,	22	0	0
,, Flowers	,,	[illegible]	[illegible]	0
Sulphuric Acid, Non-Arsenical, 140 T.	,,	5	0	[illegible]
,, ,, ,, [illegible]	,,	7	5	3
,, ,, ,, 95%	,,	[illegible]	[illegible]	[illegible]
Superphosphate of Lime, 18%	,,	[illegible]	0	[illegible]
Tartaric Acid	per lb.		[illegible]	0
Zinc Chloride	per ton	27	[illegible]	[illegible]
Zinc Sulphate	,,	[illegible]	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	April 4 1919 £ s. d.	April 7 1920 £ s. d.
RAND		
Brakpan	3 12 6	3 10 0
Central Mining (£8)	8 0 0	9 15 0
City & Suburban (£4)	11 0	6 9
City Deep	2 11 3	2 15 0
Consolidated Gold Fields	1 13 9	1 15 0
Consolidated Langlaagte	18 0	1 5 0
Consolidated Main Reef	14 0	13 6
Consolidated Mines Selection (10s.)	1 8 6	1 11 9
Crown Mines (10s.)	2 2 6	3 6 3
Daggafontein	1 8 3	18 0
Durban Roodepoort Deep	8 6	9 0
East Rand Proprietary	5 6	11 3
Ferreira Deep	12 6	13 0
Geduld	2 7 6	2 10 0
Geldenhuis Deep	11 3	12 6
Gov't Gold Mining Areas	4 13 9	4 12 6
Heriot	16 3	10 0
Johannesburg Consolidated	1 5 9	1 12 0
Jupiter	5 0	6 0
Kleinfontein	13 3	13 0
Knight Central	7 9	4 9
Knights Deep	8 0	10 0
Langlaagte Estate	18 6	16 6
Meyer & Charlton	4 8 9	4 15 0
Modderfontein (10s.)	26 10 0*	3 18 9
Modderfontein B	8 2 6	7 0 0
Modder Deep (5s.)	7 8 9†	2 10 0
Modder East	—	1 6 3
New State Areas	—	1 7 6
Nourse	14 6	13 9
Rand Mines (5s.)	2 18 0	3 12 0
Rand Selection Corporation	4 10 0	4 10 0
Randfontein Central	13 6	19 0
Robinson (£5)	13 9	12 0
Robinson Deep A (1s.)	17 6	1 2 6
Rose Deep	15 0	1 0 0
Simmer & Jack	4 0	5 3
Simmer Deep	3 3	2 3
Springs	3 5 0	2 12 6
Sub-Nigel	1 8 9	17 6
Union Corporation (12s. 6d.)	16 0	1 1 9
Van Ryn	16 3	1 1 3
Van Ryn Deep	3 10 0	4 13 9
Village Deep	16 6	14 9
Village Main Reef	13 0	7 0
West Springs	—	1 0 0
Witwatersrand (Knight's)	1 1 3	18 9
Witwatersrand Deep	13 6	10 6
Wolhuter	4 6	6 0
OTHER TRANSVAAL GOLD MINES:		
Glynn's Lydenburg	1 2 6	13 9
Transvaal Gold Mining Estates	13 6	13 9
DIAMONDS IN SOUTH AFRICA:		
De Beers Deferred (£2 10s.)	19 17 6	26 15 0
Jagersfontein	4 17 6	5 17 6
Premier Deferred (2s. 6d.)	7 2 6	11 10 0
RHODESIA:		
Cam & Motor	7 3	11 9
Chartered British South Africa	1 0 6	17 3
Falcon	13 0	11 0
Gaika	16 6	14 9
Giant	7 9	8 0
Globe & Phœnix (5s.)	1 11 6	14 6
Lonely Reef	1 18 0	2 16 3
Rezende	4 17 6	3 7 6
Shamva	2 0 0	2 0 0
Willoughby's (10s.)	6 3	5 6
WEST AFRICA:		
Abbontiakoon (10s.)	4 6	4 0
Abosso	6 3	13 9
Ashanti (4s.)	1 1 6	1 0 3
Prestea Block A	4 6	4 3
Taquah	14 6	16 3
WEST AUSTRALIA:		
Associated Gold Mines	4 3	4 6
Associated Northern Blocks	4	4 6
Bullfinch	1 9	6 0
Golden Horse-Shoe (£5)	1 15 0	1 0 0
Great Boulder Proprietary (2s.)	11 6	9 0
Great Fingall (10s).	2 3	2 6
Hampton Properties	-	1 11 3
Ivanhoe (£5)	1 18 9	2 0 0
Kalgurli	13 0	15 0
Lake View Investment (10s.)	16 9	17 0
Sons of Gwalia	8 0	7 3
South Kalgurli (10s.)	6 6	6 6

GOLD, SILVER, cont.	April 4 1919 £ s. d.	April 7 1920 £ s. d.
OTHERS IN AUSTRALASIA:		
Blackwater, New Zealand	8 9	8 9
Consolidated G.F. of New Zealand	3 9	3 9
Mount Boppy, New South Wales	7 6	4 0
Progress, New Zealand	1 9	1 9
Talisman, New Zealand	12 6	8 9
Waihi, New Zealand	1 16 0	2 2 6
Waihi Grand Junction, New Z'lnd	17 0	11 3
AMERICA:		
Buena Tierra, Mexico	1 1 0	12 6
Camp Bird, Colorado	19 3	17 6
El Oro, Mexico	16 6	14 6
Esperanza, Mexico	15 6	14 0
Frontino & Bolivia, Colombia	11 3	13 9
Le Roi No. 2 (£5), British Columbia	9 0	10 0
Mexico Mines of El Oro, Mexico	6 12 6	7 12 6
Nechi (Pref. 10s.), Colombia	11 6	10 0
Oroville Dredging, Colombia	1 2 0	1 7 6
Plymouth Consolidated, California	1 2 6	1 1 3
St. John del Rey, Brazil	17 0	16 0
Santa Gertrudis, Mexico	1 4 3	1 12 3
Tomboy, Colorado	14 9	13 9
RUSSIA:		
Lena Goldfields	1 12 6	1 2 6
Orsk Priority	15 0	12 6
INDIA:		
Balaghat	4 0	10 0
Champion Reef (2s. 6d.)	4 3	3 6
Mysore (10s.)	2 2 0	17 0
North Anantapur	3 0	4 0
Nundydroog (10s.)	19 0	13 6
Ooregum (10s.)	17 0	17 0
COPPER:		
Arizona Copper (5s.), Arizona	1 16 3	2 12 6
Cape Copper (£2), Cape and India.	2 7 6	1 17 6
Esperanza, Spain	7 6	5 9
Hampden Cloncurry, Queensland	1 0 6	15 0
Mason & Barry, Portugal	2 13 9	2 10 0
Messina (5s.), Transvaal	5 0	6 6
Mount Elliott (£5), Queensland	3 10 0	2 15 0
Mount Lyell, Tasmania	1 3 9	1 4 6
Mount Morgan, Queensland	1 4 6	1 5 0
Mount Oxide, Queensland	5 6	7 0
Namaqua (£2), Cape Province	1 17 6	1 10 0
Rio Tinto (£5), Spain	56 0 0	37 0 0
Russo-Asiatic Consd., Russia	—	10 0
Sissert, Russia	18 9	15 0
Spassky, Russia	1 10 0	1 2 6
Tanganyika, Congo and Rhodesia	4 10 0	2 6 3
LEAD-ZINC:		
BROKEN HILL:		
Amalgamated Zinc	1 12 0	1 5 0
British Broken Hill	2 3 6	2 3 9
Broken Hill Proprietary (8s.)	2 8 0	3 0 0
Broken Hill Block 10 (£10)	1 10 0	1 6 3
Broken Hill North	2 18 0	2 16 3
Broken Hill South	2 17 6	2 15 0
Sulphide Corporation (15s.)	1 5 0	19 0
Zinc Corporation (10s.)	1 5 0	19 6
ASIA:		
Burma Corporation	6 5 0	11 17 6
Russian Mining	17 6	13 9
RHODESIA:		
Rhodesia Broken Hill (5s.)	12 6	15 3
TIN:		
Aramayo Francke, Bolivia	3 5 0	4 16 3
Bisichi, Nigeria	13 6	15 0
Briseis, Tasmania	5 0	5 3
Dolcoath, Cornwall	8 0	6 9
East Pool (5s.) Cornwall	1 5 6	15 0
Ex-Lands Nigeria (2s.), Nigeria	2 9	4 0
Geevor (10s.) Cornwall	15 6	1 0 6
Gopeng, Malay	2 3 9	2 6 3
Ipoh Dredging, Malay	1 2 0	1 0 3
Kamunting, Malaya	1 18 9	2 10 0
Kinta, Malaya	2 8 9	2 17 6
Malayan Tin Dredging, Malay	2 3 9	2 8 9
Mongu (10s.), Nigeria	16 0	1 5 6
Naraguta, Nigeria	17 6	16 3
N. N. Bauchi, Nigeria (10s.)	8 3	7 9
Pahang Consolidated (5s.), Malay.	15 6	13 0
Rayfield, Nigeria	14 6	13 3
Renong Dredging, Siam	1 17 6	2 11 3
Ropp (4s.), Nigeria	1 1 6	13 6
Siamese Tin, Siam	3 1 3	4 13 9
South Crofty (5s.), Cornwall	2 0 0	15 6
Tehidy Minerals, Cornwall	12 3‡	1 11 3
Tekka, Malay	3 15 0	5 7 6
Tekka-Taiping, Malay	3 17 6	1 11 3
Tronoh, Malay	1 18 9	2 11 3

* £4 shares split into 8 of 10s. each. † £1 shares split into 4 of 5s. each. ‡ 10s. paid up.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

TUNGSTEN ORE DEPOSITS OF BURMA.

At the meeting of the Newcastle-on-Tyne section of the Society of Chemical Industry, held on January 28, J. Coggin Brown, of the Geological Survey of India, read a paper entitled "Notes on the Tungsten Ore Deposits of Burma."

For centuries there has been a small indigenous tin-mining industry in Lower Burma. Thus Ralph Fitch, an English adventurer who travelled there in 1599, has left it on record that he passed "the Iland of Tavi, from whence commeth great store of tinne; which serveth all India." One of the earliest references to the occurrence of wolfram is in a work published by Dr. Mason, an American missionary, in 1846, who states that the tungstate of iron, or wolfram sand, much resembles tin and is found in most neighbourhoods where that ore occurs. He relates how a certain Government officer erected furnaces and tried to smelt wolfram sand under the erroneous impression that he was dealing with cassiterite; but though he tried hard and raised the heat to the highest point he was capable of, the ore still remained refractory and would not turn into tin. Wolfram was re-discovered in Tavoy by the Geological Survey of India, in 1909, and was first exported in 1910, when about 400 tons was produced. At that time the world's production was about 6,000 tons of 60% WO_3 concentrates, and the chief producing countries were the United States, Portugal, and Queensland, with smaller amounts from the Argentine, Bolivia, and New South Wales. By the next year, 1911, wolfram mining was thoroughly established in Tavoy, and an output of over 1,300 tons made Burma the leading tungsten-producing country in the world, a position which she maintained easily until 1916, when the boom in the Americas caused both the production of the United States and of Bolivia to exceed hers. In 1914, out of a world's production of some 8,000 tons, Burma produced about 2,300 tons. By this time other countries had entered the list, Japan, China, Siam, the Malay States, Billiton, the Northern Territory of Australia, Tasmania, New Zealand, and Peru, while the European countries, including Germany and Austria, contributed their small portions.

Tungsten ores are almost invariably associated with the more silicious granite rocks, and the most important metallogenic province is the Sino-Malayan one, which includes Burma and the Shan States, the Malay States, the Dutch East Indies, Siam, Tonkin, and South China. The deposits of Japan and Korea may represent an extension of this province.

Wolfram and cassiterite have been found at intervals over a distance of 750 miles in Burma, always in direct association with the great granite ranges which stretch from an unknown termination in the Shan States to the extreme south of the province. The isolated occurrences of the Kyaukse, Yamethin, Karreni, Thaton, Amherst, Tavoy, and Mergui districts are links in a chain which forms the northern extension of the Indo-Malayan mountain system, and which continues south through Lower Siam and the Malay States to Banca and Billiton, forming the core of the Peninsula, and carrying its distinctive metallogenic characteristics throughout its entire length.

The geological history and structure of Tavoy, the most important mining field of Lower Burma, are simple. A series of very old sedimentary rocks, in which clay slates predominate, was intruded at an unknown period by a white, very silicious granite, which is now exposed where denudation has removed its earlier covering. The ores of tungsten and tin are always found in or near the outer margins of the granite intrusions. Both wolfram and cassiterite occur in Tavoy as segregation deposits in the granite itself, in pegmatite veins, and in quartz veins which penetrate the granite or the sedimentary rocks. Other minerals that may occur in the veins are mica, fluorite, molybdenite, pyrite, chalcopyrite, pyrrhotite, arsenopyrite, galena, zinc blende, native bismuth, bismuthinite, and, in one case, topaz. Both minerals occur in greisens, the bands of altered granite adjoining the veins themselves, and in residual, detrital, and talus deposits of the slopes. Cassiterite is transported and found in river gravels and other alluvial deposits. Wolfram is not.

It is stated in text-books that the Tavoyan field is characterized by the universal presence of tourmaline, and that columbite is a common mineral in it. Both these statements are incorrect.

Every granite intrusion in Tavoy has its associated ore-bearing veins in some part or other, though large expanses of granite are found also which do not contain veins. This is either due to the fact that veins were not formed there originally or have been cut away by denudation at a later period.

Every producing mine is situated on or near the granite contact. The veins themselves vary a great deal, yet they possess certain genetic features which may be classified as follows: (*a*) They are formed by the filling of fissures; (*b*) they often occur in parallel groups; (*c*) they often form a series of overlapping lenses; (*d*) the lenses themselves are irregular, they thin out and thicken again, or split up and reunite; (*e*) they generally possess clean and well-defined walls; (*f*) alteration of the granite walls to greisen is universal; (*g*) the vein quartz is dense, milky white, and very compact; (*h*) mica is invariably present and sulphides very often; (*i*) secondary movements of the fissures are common.

The veins are of all sizes and lengths, from small stringers to well-developed individuals which can be traced for miles. The undergrowth of the forests and the thick soil cap make it difficult to follow the veins, but several are known over a length of 1,200 ft. Both wolfram and cassiterite have a tendency to deposit in little quartz veinlets half an inch or more in thickness, and when these are in close association, and especially if the ground is soft, and can be broken down by water under pressure, valuable sources of the ores are formed. Most of the veins strike in the same direction as their parent granite masses, that is, north and south to north-west and south-east. Dips are usually very high. The mica of the veins occurs in small flakes, and muscovite is the commonest variety. Green chlorite is also found, and a lithium-bearing chlorite has been reported. Wolfram and cassiterite have a very erratic distribution in the veins. In extreme cases great slugs of wolfram up to a ton in weight have been exposed, but any profit which comes to the miner therefrom is usually lost in driving through barren ground to find the next one. This irregular distribution, coupled with a pernicious local system of mining, makes the exact valuation of the veins a very difficult matter. Contents varying from 1 to 3% are recorded, and in most cases are probably under-estimated. No mining has yet been carried on in Tavoy below about 400 ft. from the granite contact, but a study of all the available evidence leads to the conclusion that there is not much likelihood of wolfram giving out as greater depths are attained in most of the larger mines. In the author's opinion the question of the permanence of wolfram in depth is of secondary importance to that of devising means of mining narrow veins in hard granite, and of recovering the mineral content by modern methods with the poor labour supply available.

The order of deposition of the metallic minerals is a subject which has evoked much discussion, as it follows that if cassiterite was deposited at a higher temperature than wolfram there is a possibility of wolfram giving place to tin ore at depth, and of the field becoming a large tin producer, like the Federated Malay States farther south. Theoretical speculations on geochemical processes, which are impossible of reproduction in the laboratory by any means at our disposal today, may be put aside. Field evidence is convincing that molybdenite was the first ore mineral to form, that it was followed by wolfram, and it, in its turn, by cassiterite, for hundreds of specimens occur in which cassiterite was clearly secondary to wolfram in cases of mixed growths.

Although it is possible to imagine theoretical conditions under which tungsten ores in the upper part of a vein might be dissolved to form solutions, which percolating downward should have their tungsten contents precipitated in a lower horizon, the fact remains that in Burma there are no zones of any economic importance in wolfram mines which have been enriched by solution and re-precipitation in any way comparable to those, say, of copper and silver, in other parts of the world. Tungsten solutions are very easily precipitated by ferric salts, but this precipitate is colloidal and difficult to filter. It is doubtful if it would lodge in a definite deposit. Ferric tungstate and the hydrated oxide, natural tungstic acid, are in any case compounds which it is impossible to recover by ordinary concentrating devices.

The relative proportions of cassiterite and wolfram in the concentrates vary a great deal from mine to mine. The tin content in vein material is higher in granite veins than in those of the sedimentary rocks. Concentrates which are practically tin-free only occur in a few cases, and the veins from which they are derived are all in argillites or clay slates. Concentrates from surface deposits are always richer in tin ore than those from veins. The best Tavoy concentrates contain over 70% of WO_3, and all the separated material contains between 65 and 70%. A calculation based on the probable composition of the concentrates produced from 50 mines in 1918 showed that as produced the total bulk averaged 55% of WO_3 and 15% of metallic tin. These mines produced over 95% of the district's total in that year.

Mining methods of the early days were of a very primitive character, and the industry still suffers because they have never been entirely eradicated. The first discoveries were made by Burmans and Karens, who collected the ores from the outcrops. They were speedily followed by Chinese immigrants whose "crude methods exasperate equally with their bland unwillingness to improve on them." A gang of Chinese works under a contractor, who is paid according to the amount of clean, high-grade concentrate he brings in, and usually a footage rate for underground operations as well. In many cases the Chinese miner was allowed to work as he pleased, with the result that vein workings became rabbit warrens and valuable surface deposits were buried under débris. Ore concentration methods were of the crudest kind, the wolfram-bearing quartz being crushed by hammers on a flat stone and the powdered stuff washed up in a cradle or pan. The whole sequence of operations was extremely wasteful. Low-grade ore was left underground or thrown away on scattered dumps, while the losses in crushing and dressing were very high. Of late years there has been a change for the better. Tributing is still widely practised, but it is controlled to a degree hitherto unknown; deep-level exploratory work is now carried on by the aid of machine drills; concentrating mills have been designed and erected; large-scale mine plans and sections are required by the mining laws.

In a climate like the Tavoyan one, which has a monsoon rainfall of 200 inches or more, the quartz veins undergo rapid denudation and shed their contents into the surface soil. Valuable deposits are thus formed containing wolfram and tin ore in the surface covers of the hill sides, and of tin stone alone in the true water-sorted alluvium of the valleys. The greater part of the output is still derived from these.

Very erroneous ideas are prevalent in literature regarding the behaviour of the natural tungstates when exposed to the action of air and water. Thus, W. H. Emmons classifies tin and tungsten together with gold (in part), bismuth, chromium, and molybdenum. Again, R. H. Rastall writes: "The outstanding feature of the tungsten minerals is their great stability and resistance to any kind of chemical or mechanical alteration. . . .They are specially liable to occur in placers and other forms of transported deposits. . . . In this respect both wolfram and scheelite behave like stream tin, gold, and platinum." If the word "placer" means stream-borne and water-sorted alluvium, then there are no wolfram-bearing placers in Burma. Wolfram may occur at the foot of slopes, where the detrital deposits of the hill-sides merge into the true placers of the valley bottoms, but long before the clays, sands, and gravel deposits have been sorted out and transported by running water the wolfram has disappeared, though it comes from the same veins as the tin ore which remains. The rapidity with which wolfram decomposes in the surface soil is very remarkable, and is accounted for by its cleavage, resulting in its disintegration on movement with the production of a comminuted form eminently suited for chemical decomposition. Wolfram is readily leached from the outcrops of veins. The ready oxidation of its sulphide associates yields acid solutions which attack the mineral until nothing is left but cindery oxides of iron and manganese or a bloom of tungstic acid in the spaces once occupied by the crystals. R. W. Gannett has carried out laboratory experiments to determine the effect of various solutions such as are found in ground-water on tungsten minerals, and to determine what natural reagents precipitate it from solutions. He concludes that tungsten minerals are somewhat soluble. The field evidence in Burma undoubtedly supports this conclusion. In this connection the author points out that the natural sulphides of molybdenum and bismuth are also leached, dissolved, and oxidized away in their passage from a vein through a soil cap toward the valley deposits in tropical countries.

All observers are agreed that the wolfram, cassiterite, scheelite, and associated minerals emanated in some form or other from the original molten granite, but there are differences of opinion as to the manner in which they were collected and then deposited in the veins where they are now found. It is generally admitted that after the crystallization of the main mass of the granite a watery and highly acid mother liquor was left in which the tungsten and tin compounds were dissolved. Whether this mother liquor derived its water from the original magma, or from some external source is a matter of speculation, as also is the part taken by mineralizing gases in the operations. The facts on which we have to build our theories are these: that tourmaline, which would indicate the presence of both fluorine and boron, is absent; that calcium fluoride is a widely-distributed accessory mineral; that sulphides of various elements are common and persistent; that wolfram and cassiterite occur in pegmatites; and that some of the pegmatites can be observed passing laterally into quartz veins of the ordinary type carrying the minerals. The presence of fluorite and the fact that both tin and tungsten form highly volatile compounds with fluorine, coupled with Daubree's synthesis of cassiterite by the action of water on tin fluoride, are used by the advocates of the pneumatolytic hypothesis in support of their views. Whatever the inner details of the processes may have been, it seems certain that the mineral veins appeared as a direct result of fractional crystallization, through a series of varying phases, induced in the original magma by decreasing temperature.

The following are other contributions to this subject by Mr. Coggin Brown:

"The Origin of the Wolfram-bearing Veins of the Tavoy District." *J. Asiat. Soc. Bengal, N.S.*, 13, [2], 202—203. (Summary only).

"Solubility of Tungsten Minerals." *Min. and Sci. Press*, 1917, *155*, 302—303.

"Economic Geology of Tavoy." Lectures delivered at Tavoy under the auspices of the Mining Advisory Board, 55—70. Superintendent, Government Printing, Rangoon, 1918.

"The Genesis of Tungsten Ores." *Geol. Mag.*, Jan 1919, 44—46.

"The Cassiterite Deposits of Tavoy." *Rec. Geol Sur. India*, 1918, *40*, [1], 23—33.

With A. M. Heron: "The Distribution of the Ores of Tungsten and Tin in Burma." *Rec. Geol. Surv India*, 50, [2], 101—121.

GENESIS OF TIN AND TUNGSTEN DEPOSITS.

At the meeting of the Institution of Mining and Metallurgy held on March 18, Dr. W. R. Jones read a paper entitled "Tin and Tungsten Deposits: the Economic Significance of their Relative Temperatures of Formation." This paper is an elaboration of Dr. Jones's views, referred to in the Magazine for June, 1918, that deposits in which cassiterite and wolframite occur in intimate association were formed in a lower temperature zone than were the bulk of the tin deposits free from wolframite and that cassiterite is a higher temperature mineral than wolframite. As a corollary to this theory he suggests that some of the deposits in Tavoy district, Burma, where cassiterite and wolframite occur in intimate association, will be found in depth to resemble the tin deposits in the Federated Malay States, Cornwall, and parts of Siam.

As bearing on the theory, the author first considers the classification of various types of tin and tungsten deposits.

All known tin and tungsten deposits occurring *in situ* may be placed in one or other of the following classes:

(1). Where cassiterite, wolframite, and scheelite occur as primary minerals in granite and rhyolite, generally as segregations.

(2). Where they have been formed as contact-metamorphic deposits.

(3). Where they occur in veins of pegmatite, aplite, rhyolite, and quartz-porphyry.

(4). Where they occur in quartz veins of direct igneous origin.

(5). Where they occur as replacement deposits of hydrothermal origin.

The relative temperatures of formation which characterize the different modes of occurrence are indicated by very strong field evidence. The temperature, for example, within an igneous magma which solidified to form a holocrystalline rock, such as granite, must have been higher than that where the metamorphic action, as seen clearly in the field, was considerably less than nearer the intrusion. It is then safe to assert that, where wolframite occurs as an original constituent of a segregation in granite, it must have been deposited at a higher temperature than where it occurs in a quartz vein some hundreds of feet from the intrusion, or in a calcareous or other rock, which has, by hydrothermal action, been partly replaced by deposits of wolframite.

The temperature of formation of contact-metamorphic deposits of tin or tungsten minerals can best be investigated from a study of the secondary minerals formed at, and near, the contact. The field evidence points to the fact that the temperature varied with the kind of rock into which the igneous magma was intruded, and with the conditions which determined the pressure then developed. For example, the temperature developed at, and near, the contact of granite with metamorphosed limestone would be different from that with mica-schist; and the temperature at, and near, the contact of granite and a rock of a yielding nature, and which had room to yield, could be reasonably expected to be less than that which would obtain in the case of an unyielding rock, or of a rock with no room to yield to pressure. The temperature would not, in some cases, under the latter conditions be far below that of the granite magma, and could, under certain conditions, be even higher than that of this magma.

Granite pegmatite veins represent the later phase of the main granite intrusion, and are the fillings of fissures formed in the consolidating granite and in the neighbouring rocks, by the residual and more acid differentiation product of the parent magma which gave birth to the granite intrusion. It is very generally accepted that, in addition to their other chemical functions, the mineralizing gases and solutions which had become more concentrated in this residual and more acid part of the main magma, acted as powerful fluxes, retarding the crystallization of the residual magma, this eventually taking place at relatively low temperatures when compared to the temperature at which the ordinary granite crystallized. Pegmatite veins have been followed away from granite into the neighbouring rocks for hundreds of feet, and this fact, with other field evidence, places it beyond reasonable doubt that the temperature of formation of such veins was lower than that which obtained in the main granite magma. Numerous cases are known of pegmatite veins which, when followed as continuous veins in the granite and in the metamorphosed rocks, have become less rich in felspar, and have passed into quartz veins. It is also generally true that such quartz veins are far more numerous outside the zone in the immediate neighbourhood of a granite intrusion than are pegmatite veins; in other words, quartz veins genetically related to the granite are known at a much further distance from the granite intrusion than are pegmatite veins. The alteration of the walls of such quartz veins is in general, and especially in the parts most remote from the granite, less marked than that of the walls of pegmatite veins.

This field evidence points to a lower temperature of formation of quartz veins than of pegmatite veins, but it must be borne in mind that quartz veins are very frequently found intrusive in granite, that a good deal of greisenization may be present in the walls of such veins, and that an abundance of mica occurs in the margins of some quartz veins intrusive in metamorphosed rocks. These facts show that the difference in temperature of formation of pegmatite and certain quartz veins may not have been great.

On the whole, however, it may be regarded as established that magmatic quartz veins were formed at somewhat lower temperatures than the pegmatite veins, and this is very clearly the case with parts of the quartz veins remote from the granite intrusion.

The quartz veins referred to above are not to be confused with those in which the quartz was deposited by hydrothermal action, but are veins which, like the pegmatite and aplite veins, were formed from the intrusion of the residual and more acid magma during the later phase of the granite intrusion. They are, therefore, genetically connected with the parent igneous magma more directly than quartz veins in which the quartz is of hydrothermal origin. The latter type of quartz veins were, it is plain, deposited at a lower temperature than were the pegmatite, aplite, and most of the quartz veins of direct igneous origin.

In the deposits where wolframite and scheelite occur as replacements, the field evidence appears to show that hydrothermal water was the agency at work, and that the temperature was lower than that which obtained in any of the other four classes.

The foregoing conclusions, based on field evidence as to the relative temperatures of formation of the five classes of deposits, may be summarized thus: The segregation and contact-metamorphic deposits were formed at a higher temperature than the pegmatoid deposits; these latter were formed at a higher temperature than were most, if not all, of the quartz veins of magmatic origin; and these in turn were formed at a higher temperature than were the quartz veins of hydrothermal origin. Finally, the replacement deposits were formed at comparatively low temperatures.

A study of the assemblages of minerals characteristic of the various classes of deposits points to the same relative temperatures of formation of the deposits, but the author will deal with this part of the subject later in a separate paper on the genesis of tin and tungsten minerals.

A study of the known deposits of the world in the light of the author's classification shows the following conclusions:

(1). The bulk of the world's supply of cassiterite is derived originally from pegmatoid and quartz veins.

(2). The bulk of the world's supply of wolframite is derived originally from quartz veins.

(3). The bulk of the world's supply of scheelite is derived originally from quartz veins.

(4). Where cassiterite occurs to the total, or almost total, exclusion of wolframite and scheelite, high temperature minerals such as tourmaline and topaz are common.

(5). Where wolframite or scheelite occur to the total exclusion of cassiterite, tourmaline and topaz are altogether absent or present in small quantities only.

(6). Where cassiterite and tungsten minerals occur together, and where the former predominates, tourmaline and topaz are generally present.

(7). Where tungsten minerals occur in association with cassiterite, and where the former are the predominant minerals, tourmaline and topaz are generally absent.

It is clear that the intimate association with cassiterite of high temperature minerals, such as tourmaline, topaz, and felspar in the deposits which have provided the bulk of the world's output of tin, and the absence of these high temperature minerals from the wolfram and scheelite deposits which have produced the bulk of the world's supply of tungsten minerals, points very definitely to the fact that cassiterite is a higher temperature mineral than wolframite and scheelite. In the author's opinion, this is a fact of the greatest importance in its relation to the persistence or non-persistence in depth of some of the world's most important tin and tungsten deposits, notably those of Tavoy District, Burma.

The author realizes that unless he can adduce convincing evidence in support of this statement that cassiterite is a higher temperature mineral than wolframite, then his views as to the persistence in depth of certain tin and tungsten deposits in Burma lose much of their force. Dr. Morrow Campbell emphatically maintains that there is no evidence in the Tavoy District, Burma (by far the most productive wolframite field in the world) that cassiterite is the higher temperature mineral of the two, and he states that, on the contrary, wolframite appears to be a higher temperature mineral than cassiterite. In support of this he draws attention to certain specimens exhibited by him showing crystals of cassiterite which apparently had been deposited on wolframite. The author had the privilege of examining these specimens, and he disagrees with Dr. Morrow Campbell's interpretation of them. It is true that crystals of cassiterite are occasionally found in the Tavoy District on wolframite, but it is equally true that specimens of wolframite are found on cassiterite, and several specimens can be produced showing both cases very clearly. Stout crystals of cassiterite, unless comparatively very small, must necessarily stand out in relief above the surface of tabular crystals of wolframite. The author showed a specimen in which cassiterite crystals appear to have been formed on a larger tabular crystal of wolframite, but one corner of the wolframite crystal is occupied by cassiterite which could not, therefore, have been formed after the completion of the wolframite crystal. It will also be seen in the same specimen that a small crystal of cassiterite is almost completely embedded in wolframite.

This question can, however, be investigated on other and more reliable data than a few hand-specimens. It is a highly significant fact that solid lumps of wolframite from a wolframite-cassiterite deposit, even when no cassiterite can be seen by the naked eye nor under pocket lens, are found on analysis to carry appreciable quantities of tin. Under the microscope small grains of cassiterite can occasionally be seen completely surrounded by wolframite. Several hundreds of analyses, conducted, chiefly for commercial purposes, under the supervision of H. R. Pepper in

Tavoy, established the facts that out of some thousands of tons of concentrates sampled and assayed, in no case was a parcel of wolframite found free from tin; that hand-picked cleavage fragments of wolframite in which no cassiterite could be detected by a pocket lens were found to carry from 0·2% to 0·5% of tin; and that lumps of cassiterite quite free from any tungstic oxide were very common.

It is not suggested here that, in deposits where cassiterite and wolframite occur in intimate association with one another, the cassiterite was in all cases deposited before the wolframite. The zone of temperature was suitable for the deposition of the two minerals, and numerous specimens can be shown in which the two were deposited simultaneously. So intimately intergrown are these two minerals in some areas, as at one or two small mines in Tavoy, Burma, and at the Mawchi Mines, Burma, that the tin-wolfram concentrates defy magnetic separation, and those from Mawchi (apart from those carrying a little scheelite) have to be treated chemically, and not mechanically, as are the bulk of the Burma mixed concentrates. It seems to the author beyond question that when so intimately associated the two minerals were deposited simultaneously.

The important point in connection with the deposition of these two minerals which the author wishes in particular to emphasize is that during the ascent of the mineralizing gases and solutions in the magma which filled the fissures to form the pegmatite and quartz veins, cassiterite was deposited in a zone of temperature that was too high for the deposition of wolframite, some of it was deposited paragenetically with the wolframite in a wide zone of temperature suitable for the deposition of the two minerals, and some of the wolframite was carried beyond this zone to a zone of lower temperature nearer the surface by mineralizing gases and solutions from which almost all the cassiterite had previously been deposited. In other words, cassiterite was the first of the two minerals to be deposited by the ascending mineralizers as they pursued their course through the fissures, along a falling temperature gradient, toward the peripheries of the granite intrusion, and into the surrounding rocks.

In September, 1917, the author drew attention to the fact than in Tavoy District, Burma, the wolframite lodes in the metamorphosed sedimentary rocks farthest removed from the granite contact carried, in general, a lower percentage of tin than did those near the contact, and than did the lodes intrusive in the granite. This was not accepted as being correct by Dr. Morrow Campbell, for in June, 1918, he made the statement that the reverse was the case, namely, "that the ratio of cassiterite to wolfram is greater in veins in sedimentary rocks than in those in the granite below," and that "when in granite the ratio of tin to wolfram appears to fall as we move down from the vicinity of the contact."

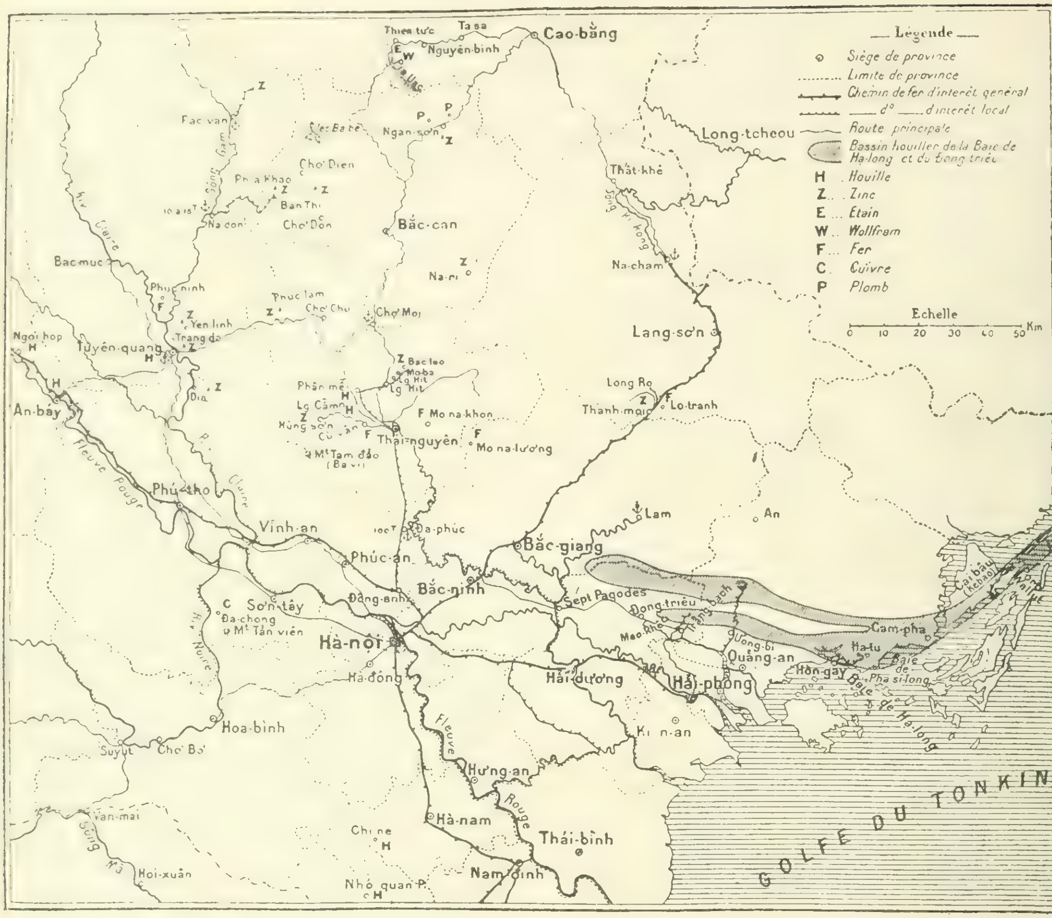
When the present writer made his statement in September, 1917, he had before him the results of many hundreds of assays of parcels of wolframite concentrates from various parts of the Tavoy field, and he had also seen a large number of the mines of the district. It is gratifying to him that after four years' work in the same district one of the officers of the Geological Survey Department of India supports his conclusion, in the following words: "Cassiterite is present in relatively larger amounts in lodes traversing granite than in others which pierce sedimentary rocks, though there are exceptions to the rule."

It is, of course, well known that tin lodes occur in metamorphosed sediments—the author described a number of such mineralized areas in 1915—but the point here emphasized is that where cassiterite and wolframite occur in the same field, the ratio of tin to tungsten is less, in general, in the lodes farthest from the granite than in those traversing the granite. Scrivenor has found this to be the case also in parts of Malaya. He states as follows: "In Selangor the richest shoots of wolfram ore are generally found at the contact of granite and schist; where the lodes traverse the schists they contain fairly pure wolfram, on the contact they contain mixed ore, while within the granite they become richer in tin and poorer in wolfram."

Dr. Malcolm Maclaren has furnished definite evidence as to what happens at East Pool, Cornwall. He states as follows: "The wolfram zone occurs near the top of the tin zone. In the Great Lode wolfram was most plentiful from the 140 to the 196 fathom levels. In the Rogers lode, so far as it has been explored, wolfram is most abundant on the 196 fm. level. In the latter lode, however, the top of the tin zone is some 25 to 30 fathoms lower than in the Great Lode. The downward succession of economic minerals at East Pool is roughly: copper ores from surface to 140 fathoms, wolfram from 140 to 200 fathoms, and tin from 140 to 340 fathoms (south-dipping lodes) and possibly to 450 fathoms (north-dipping lodes). It is impossible to ascribe this vertical succession of minerals to any other cause than to decreasing temperature of metalliferous solutions with approach to surface."

There appears to be evidence pointing to the same conclusion as to the relative temperature zones of deposition of these two minerals in the tin and tungsten fields of Lower Burma, of Siam, of Malaya, and of the Dutch East Indies. The granite ranges of Lower Burma have now been proved to be continuous to Siam and through the Malay States, and there is a good deal of evidence in support of the hypothesis advanced by the author some time ago, namely, that denudation has been greater in Malaya than in Lower Burma, and that possibly in parts of Lower Burma deposits more like the tin deposits of Malaya will be found in depth.

One of the objects of this paper is to focus attention on the economic importance of determining, for any particular tin and tungsten occurrence, the relative zone of temperature to which it belongs, and to deduce therefrom, and from other evidences, what the prospects are as to the persistence, or non-persistence of the ore in depth. This question of relative persistence is one of the most important and perplexing that the geologist and mining engineer have to face. Cassiterite is being worked at Dolcoath, Cornwall, below 3,000 ft. from the surface, and the deposit there has continued to yield cassiterite to a depth of over 1,920 ft. in granite below its contact with the killas; wolframite has been mined at East Pool, Cornwall, down to the 1,800 ft. level, below which the percentage of cassiterite to wolfram increases; at White Oaks, New Mexico, hubnerite has been found at a depth of 1,350 ft.; and scheelite is mined at a vertical depth of 510 ft. at the East Union Mine, Atolla, California. These facts are encouraging in considering the prospects of the persistence in depth of the wolfram-tin deposits of Tavoy, the most productive wolfram district of the world. The Tavoy lodes are of quartz; they carry wolframite and cassiterite in proportions varying from 0·5% to 25·0% Sn in different lodes; tourmaline is rare; certain sulphides are abundant and a little blende and galena are present in some lodes. In other words, the Tavoy deposits hitherto exposed are above the geological horizon where cassiterite could be expected to occur to the total, or almost total, exclusion of wolframite.



Map of Tonkin, showing position of Tin and Tungsten Deposits.

TIN AND TUNGSTEN IN FRENCH INDO-CHINA.

In recent issues we have quoted articles from the *Far Eastern Review* on the mineral resources of French Indo-China. Herewith we give a précis of an article appearing in the December issue dealing with tin and tungsten in Tonkin.

The tin and tungsten mines of Tonkin are situated in the granite massif of the Pia-Oac, about 10 kilometres west of Nguyen-Binh and 56 kilometres from Cao-Bang, in the far north of the Province. They are reached from Hanoi by rail as far as Dong-Dang, 163 kilometres by automobile or cart from Dong-Dang to Cao-Bang viâ That-Khe (125 kilometres) and by cart or on horse-back from Cao-Bang to Thien-Tu'c (56 kilometres) and beyond. The ores are brought down this road, and the cost of transport to the point of shipment is from \$50 to \$60.

Prior to the French occupation the tin gravels in the Thien-Tu'c valley were actively worked by the Chinese. The lodes of wolfram and tin ore were also exploited. The Chinese rejected the wolfram, but the French miners have since carefully recovered this from the waste heaps. Work on the veins at this time was only slightly developed, owing to the hardness of the rock and the small proportion of tin ore as compared with wolfram. In addition the cassiterite in veins containing wolfram was not liked by the smelter. To-day even, in spite of the improved separation of the two minerals, it is difficult to obtain a tin 98 or 98·5% pure, while alluvial ores furnish a metal containing as high as 99·5% fine.

The massif of the Pia-Oac, 1,930 metres high, consists of a granulite piercing the old schists. The widest veins are found in the schists at the contact. In the granulite characteristic veins have a varying thickness of 0·1 metres to 0·3 metres and are sometimes numerous enough to form stockworks.

The most important lode workings are on the St. Alexandre and Robert concessions. On the St. Alexandre concession, the "Etains et Wolfram du Tonkin" (a limited liability company with a capital of Fr. 3,500,000) works about a score of veins. The most important vein by reason of its average width (0·5 metres), its continuity (it has been prospected for more than 600 metres in length and to a depth of more than 100 metres), and by the richness of its contents, is the St. Alexandre vein. The ores are submitted to a careful sorting and the middlings are sent to crushers and concentrators, the mixed concentrates going to the electro-magnetic separator installed at Thien T'uc. The capacity of the crushing plant is 3 tons per hour and it absorbs 25 to 30 h.p., which is furnished by a small hydro-electric plant. The electro-magnetic separator produces concentrates consisting as to 70% of wolfram containing 70 to 75% WO_3 and as to 30% of tin concentrate containing 30% of tin. The production, which has been continuously increasing since the commencement, was 245 tons in 1916. It will be increased in the near future by the installation of machine-drills, for which the necessary power will be supplied by the hydro-electric plant at Ta-Sa. The mine employs 11 Europeans and a thousand natives (600 Chinese and 400 Annamites). On the Robert concession stockworks and the surface debris in the neighbourhood of the same are worked. One of these stockworks has been uncovered for more than 100 metres. This is being worked by open-cut, especially on the disintegrated parts. The surface debris is rich in minerals in places, and affords, during the rainy season, very profitable working. The production of this mine was, in 1916, 50 tons of mixed ore, yielding 20 to 30% of tin and 35 to 40% WO_3. There are 10 Europeans and 200 Chinese and Annamites employed.

Of alluvial workings the Beau-Site and Ste. Adele are the most important. The Beau-Site concession is worked by the Société des Mines d'Etain du Haut Tonkin (a limited liability company with a capital of Frs. 375,000) which works alluvial deposits of different characteristics according to the altitude at which they are situated. The "lower" deposits, situated in lower parts of the ravines, are made up of heaps of rubble formed at the foot of the crystalline massif in the depression existing at the contact of the granulite and the schists. The rubble is composed of large lumps of granulite embedded in a mass of sandy clay produced by the decomposition and carrying down of the granulites situated up the river. This has produced in these masses a certain enrichment. The method of working these deposits consists of disintegrating and carrying away by means of water currents this sandy-clayey mass, which is cleansed at the foot of the works by a vigorous raking and is then treated in the sluice. The only difficulty of this form of working is the unintentional carrying of large blocks of granulite. The "upper" workings consist of rubble which has been decomposed to a greater extent than that below. At the lower workings, in which the removal of sterile material by washing is the principal operation, Annamite labourers are employed, paid by the day. The upper workings employ Chinese coolies on piece-work, and for washed ore they are paid 20 to 40 cents per kilogramme. The mine employs three Europeans, 200 Chinese, and 100 Annamites. The production in 1916 was 90 tons of mixed ore containing 30 to 35% WO_3 and 25 to 30% of tin.

The Sainte-Adele mine is to be worked by the Société des Etains et Wolfram du Tonkin shortly. This occupies the valley of Thien-T'uc. The valley runs east and west and has been filled by an alluvial deposit consisting of pieces of all dimensions fallen from the flank of the Pia-Oac and embedded in a mass sometimes sandy and sometimes clayey. Investigations by means of numerous pits show the alluvium to have a workable depth at the edges of the basin of 20 metres, and in the centre 50 metres, though bed-rock has never been reached. The volume of alluvial deposit to be treated is estimated at 10,000,000 cubic metres. Its richness increases with depth. At 25 metres it shows an average of 3 kilogrammes to the cubic metre, while at certain places 30 kilogrammes to the cubic metre have been found. The ore is cassiterite associated with 4 to 5% of wolfram. The company is establishing inclined planes and electric windlasses at two points. By this means the alluvium will be raised to the level of rails on which cars drawn by locomotives will take the earth to the washing stations. The waste, which consists of all larger than 20 mm., will be discharged at a point in the valley where the alluvium is poor. Later it will be sent back into the empty spaces made in the course of working, at points where bed-rock has been reached. The washing installation will consist of four sections, capable of handling 250 cubic metres of alluvium in 24 hours. Two of these sections are actually under construction. The cassiterite will be smelted on the spot. The employment of electrical furnaces is contemplated, but at present preliminary trials are being made with Chinese furnaces. The power necessary for the various installations (washing, locomotives, windlasses, pumps, electro-magnetic separators, lighting for the workyards and shops) will be supplied from the hydro-electric station at Ta-Sa which will also furnish power to the Saint Alexandre mine.

The Ta-Sa hydro-electric plant has been constructed at kilometre 34 on the road from Cao-Bang to Nguyen-Binh. It employs, under a fall of 62 metres, the water of the Hyuyen-Binh river, which amounts to from 1,500 to 2,000 litres per second during the dry season, corresponding to a minimum of 1,000 h.p. A dam of reinforced concrete, four metres high, on which is the new road from Cao-Bang to Nguyen-Binh, retains the water and diverts it into a canal 1,500 metres long, constructed partly of reinforced concrete and partly of masonry. For a distance of 400 metres the canal passes through a tunnel. The penstock is 125 metres long with an internal diameter of 650 mm. A second pipe is anticipated. The generating plant consists of five sets of turbo-alternators of 250 h.p. Two sets are already in place, and a third will be installed in the near future. The alternators supply a three-phase current of 50 periods with a voltage of 440. Transformers on the spot will raise the voltage to 10,000, and on arrival at Thien-T'uc and Saint Alexandre the current will be reduced to 110 volts at transforming stations. The mains, of aluminium, are supported by posts of reinforced concrete 10 metres high and are placed 100 metres apart. The first portion of the programme of the Société des Etains et Wolfram only requires the use of 500 h.p., of which 200 h.p. is for working the alluvial deposit of Sainte Adele, and 200 h.p. for working the veins at Saint Alexandre. Further expansion will depend on circumstances.

HEMATITE IN RUSTENBURG DISTRICT, TRANSVAAL.

The *South African Journal of Industries* for December publishes a paper by A. L. Hall, of the Geological Survey, and C. J. N. Jourdan, Deputy Inspector of Mines, describing the deposits of hematite iron ore on Farm Buffelshoek No. 151 in the Rustenburg district of the Transvaal.

Buffelshoek is situated on the Crocodile River, and lies between longitudes 27° 20′ and 27° 24′ east and latitudes 24° 39′ and 24° 42′ south. The river forms the eastern and northern boundaries, and, except for a prominent range of hills rising to an altitude of about 1,000 ft. and crossing the farm nearly due east and west, the country is very flat. The base of the hills forms only a small portion of the area of the farm. It is in this range of hills that the iron ore occurs. The nearest railway stations are Warmbaths on the Pretoria-Pietersburg line and Brits on the Pretoria-Rustenburg line, from either of which railheads the farm is distant approximately 75 miles.

Up to the present no mining and only a little pro-

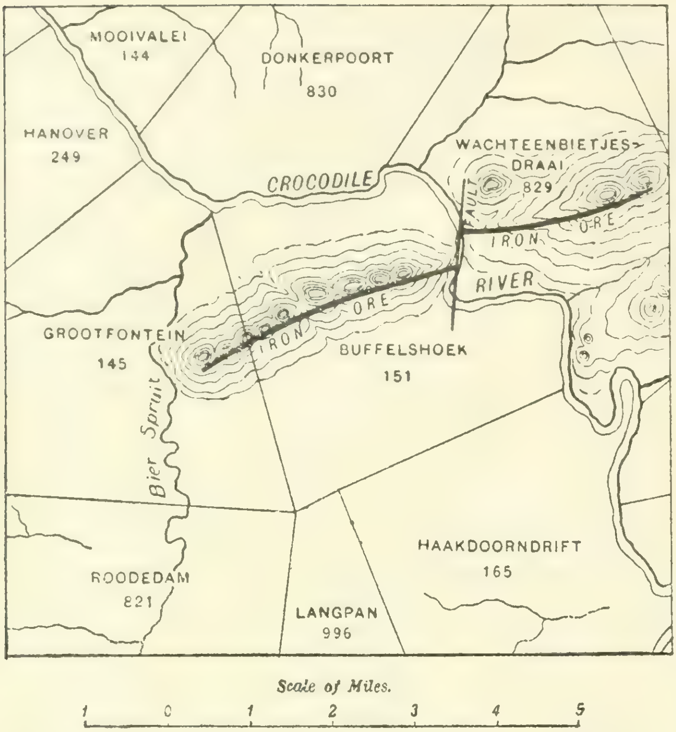


FIG. 1. SITUATION PLAN OF THE BUFFELSHOEK IRON ORE.

specting has been carried out, but that the existence in the district of an iron ore of good quality was known to the ancients may be deduced from the old workings on the farm Wachteenbietjesdraai No. 829, immediately east of Buffelshoek, and also on the farm Klipgat No. 672, east again of Wachteenbietjesdraai. These workings were not seen by the writers, but they are reliably informed by J. H. Williams, the discoverer of the iron occurrence of Buffelshoek, that surface indications go to show that quite extensive operations were carried out on those farms and particularly on Klipgat. There is also evidence in the nature of slag heaps and portions of tuyeres and so forth to indicate that actual smelting for iron was practised in addition to the mining or quarrying of the ore. These workings are all on the same geological horizon, but the ore-bodies worked at that time were only small pockets. The extensive occurrence of hematite on Buffelshoek was found by J. H. Williams. From the Klipgat and Wachteenbietjesdraai old workings the banded ironstones were followed westward and eventually into the bed of the Crocodile River, where an extensive body of a superior iron ore can be seen. From this point the iron formation continues westward along the higher slopes of a prominent ridge facing south.

The ridge is displaced by a minor fault, which runs more or less along the river roughly north and south, so that the eastern continuation of the ridge lies some 300 to 400 yards toward the north, then continuing eastward for several miles as a well defined feature. West of the river the banded ironstones continue also along a strongly marked ridge for some few miles. In the bed of the river, near its left or western bank, the banded ironstones suddenly end—probably against the fault—in a very fresh and well exposed outcrop, which was examined and sampled in detail. It could be clearly seen that the iron ore continues from the river westward as well as eastward — allowing for fault displacement — along the same geological horizon (see Fig. 1). From this conveniently accessible outcrop the flats toward the south are diversified by a low linear feature, about one mile upstream, due to quartzite. This is most probably the Daspoort quartzite. A second similar quartzite ridge, also about one mile further toward the south, most likely corresponds to the Magaliesberg quartzite (see Fig. 2).

The banded ironstones in all probability represent the northern facies of the Timeball Hill series, which, unlike the type section west of the capital, consists of banded ferruginous shales or jaspery slates, generally similar to the Lower Griqua Town series of north-west Cape Province, and is due to changes in sedimentation beginning along the Steelpoort River, but gradually intensified northward through Malips Drift and Chuniespoort toward Potgietersrust.

A little to the north of the crest line of the ridge, the banded ironstones give place to dolomite, and in the bed of the river a well-marked succession of quartzite, overlain by chiastolite slates, marks the upper edge of the ferruginous slates, so that there is little doubt that the position of the hematite ore is between the Timeball Hill quartzites (which consist in the northern facies of a single non-ferruginous quartzite band) and the base of the Pretoria series (see Fig. 2). The dip of the succession is to the south-east and varies from about 45° to 60°.

Fig. 3 is a section across the good outcrop on the left bank of the river, and shows the banded ironstone dipping at about 60° to the south-east. It was not possible to determine how far further layers of ferruginous slates are represented in the sandy stretch of the river bed between the locality figured and the quartzite upstream, but some time ago, when the bed of the river was less filled with sand, additional bands of hematite were well exposed a little above the outcrop examined by the authors.

It will be seen from Fig. 3 that the banded ironstones consist of three layers of solid hematite, respectively 21, 4, and 17 ft. thick, separated by two layers of silicious rock 2 ft. and 3 ft. thick, respectively. These values represent true thicknesses, after allowing for the dip of 60°. The above is the minimum order of magnitude which the iron deposit reaches.

Throughout the Transvaal, wherever the northern facies of the Pretoria series is represented, the banded ironstones of the Timeball Hill series, like those intercalated in the dolomite formation, are hard, usually thinly bedded silicious slates, presenting a striped appearance in variegated colours, owing to the alternation of reddish jaspery silicious with dull grey highly ferruginous bands. The Buffelshoek example is essentially similar to the same horizon elsewhere in the eastern and northern Transvaal, with the important and economically most significant difference that the ferruginous layers are many times thicker than those composed more or less wholly of silica.

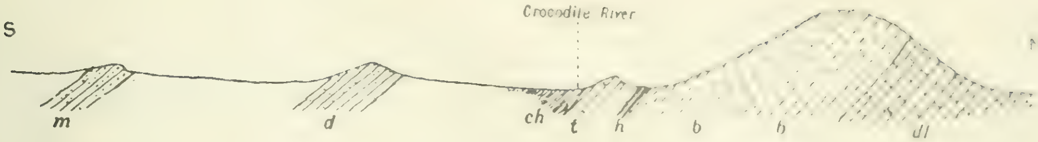


FIG. 2. SECTION FOUR MILES LONG ACROSS BUFFELSHOEK.

m.—Magaliesberg Quartzite. *d.*—Dasport Quartzite. *ch.*—Chiastolite Slate. *t.*—Timeball Hill Quartzite *h.*—Hematite in Banded Ironstone. *dl.*—Dolomite.

FIG. 3. OUTCROP OF HEMATITE ON LEFT BANK OF CROCODILE RIVER.

h_1.—Hematite 21 ft. thick b_1.—Banded Silicious Ironstone 2 ft. h_2.—Hematite 4 ft. b_2.—Banded Silicious Ironstone 3 ft h_3.—Hematite 17 ft.

The Buffelshoek ore can be classed as a variety of contemporaneous bedded sedimentary iron ore, forming part of the succession of the Timeball Hill series (northern or Heanertsburg facies), in which the proportion of hematite has been enormously increased, so as to form solid masses of ore, yards thick, as compared with fractions of an inch elsewhere. A fresh lump of the ore is a non-magnetic, very hard, dark silvery grey or dull lead grey heavy rock, very fine grained to compact on a fresh fracture, but retaining traces of its sedimentary origin on the dull black smooth weathered surfaces, which are ruled by extremely delicate and closely packed parallel lines. Throughout the 42 ft. of thickness, shown in Fig. 3, these characters are uniformly maintained.

The few feet of silicious layers, intercalated in the hematite bands, are very similar in appearance to what is commonly referred to as "calico rock" among miners and prospectors, and consist of thin bands of silica from ½ in. in width downward, alternating with thin layers of hematite, often not more than ¼ in. or ⅛ in. wide. A sample was taken right across the outcrop, but excluding the two bands of silicious calico rock; this gives a sample width of 42 ft. of hematite ore. The following analysis was furnished by Dr. Moir, Chemist to the Department of Mines and Industries:

ANALYSIS OF BUFFELSHOEK HEMATITE ORE.
Width of sample 42 ft.

	%	
Fe_2O_3	93·5	63·3% of metallic iron.
FeO	2·30	
SiO_2	3·35	
Al_2O_3	0·50	titanium and chromium together amount to 0·10%
P_2O_5	0 05	
Ignition	0·27	
Sulphur	Nil.	
Manganese	Nil.	
Vanadium	Nil.	
	99·97	

Dr. Moir explains that owing to the great hardness of the ore about 1% of iron was introduced during grinding and has been allowed for in the above statement, but, not being accurately determinable, the analysis is subject to an error of about ½%. A glance at the analysis shows that one is dealing here with an ore of remarkably high grade, and one that is scarcely approached or equalled by any iron ore so far known in the Union. The very low amount of phosphorus allows it to be classed as a Bessemer ore. It follows that the Buffelshoek hematite ore, provided sufficient quantities are available, is a mineral deposit of immense potentialities.

It has already been explained that the collective thickness of the solid bands of hematite amounts to 42 ft., exclusive of 5 ft. of intercalated silicious calico rock. The latter should present no serious problem in development, since it is quite distinct in appearance from the hematite bands, and hence readily amenable to thorough sorting. These 42 ft. are the minimum thickness of the ore at the outcrop in the river. From the latter westward, across Buffelshoek, the banded ironstones continue without a break for at least 2 miles and also include beds of solid hematite. The specific gravity of the ore was determined as 5·24, and, in order to estimate the available tonnage of iron on a conservative basis, an average thickness of 35 ft. instead of 42 ft. has been taken, because the collective width of the solid hematite bands is, in the nature of the case, likely to fluctuate. The content of metallic iron has for similar reasons been taken on the modest side, 55%, which is well below the analysis, and the specific gravity has been reduced to 5. From these data it follows that a strip of ore 2½ miles long and 35 ft. thick would represent 390,000 tons of metallic iron for every ten feet of exploitation on the dip. This result refers to Buffelshoek, and does not take any account of farms on the east side of the river. What the character of the banded ironstones is on that extension of the ridge the writers cannot say, but, judging from the nature of the débris seen along the footslopes, it was evident that much hematite existed here also. Assuming, therefore, that the quality of the ore remains more or less like that found at the surface, the available tonnage is on a scale to satisfy even an iron industry, where it is essential that one should be able to look a long way ahead.

Once the continuity of the rich ore is proved in strike and depth, an ideal mining proposition will have been established. The physical features and contours lend themselves admirably for open-cut mining for many years. The ore could be broken at a cost of probably 3s. 6d. per ton.

COPPER SMELTERS IN NORTH AMERICA.

The *Engineering and Mining Journal* for January 17 gives particulars of copper smelters in North America. The table is reproduced herewith. During 1919, the demand for copper dropped materially, so that smelting works and refineries operated at only about 50% of normal. With the exception of the enlargement of the United Verde Copper Co.'s works, changes in smelting plants consisted mainly in the installation of new machinery to give increased efficiency, rather than greater capacity. Among the smelters in the 1919 list not included in that of 1918 are those of the Afterthought Copper Co., operating a small reverberatory plant on flotation concentrate; the British America Nickel Co., which hopes to blow in its new smelter early in 1920; the Democrata Cananea Sonora Copper Co., a small blast-furnace plant in Mexico which operated during a part of the year; the Douglas Mountain Copper Mines Co., which has a small reverberatory in Moffat County, Colorado, now out of operation; El Fuerte Mining & Smelting Co., owning a small blast-furnace in Sinaloa, Mexico, which it hopes to operate in 1920; the Compania Metalurgica Mexicana, principally a lead smelter, but having one small copper furnace; the Compania de Minas de Mexico, S.A., which finds a small copper blast-furnace the most convenient way of collecting silver, making a 12% matte, but which has been forced to discontinue owing to the destruction of the Yaqui River branch of the Southern Pacific; the Arizona Smelting & Power Co., which has a small blast-fur-

PRINCIPAL COPPER SMELTING WORKS OF NORTH AMERICA.

		Blast Furnaces		Roasting Furnaces		Reverberatories		Converters	
		No.	Annual Capacity	No.	Annual Capacity	No.	Annual Capacity	No.	Annual C'p'city
Afterthought Copper Co.	Ingot, Shasta Co., Cal.	2	(a)	1	45,000	1	80,000	—	
American Smelting & Refining Co.	Aguascalientes, Mex.	6	480,000	—	—	—	—	4	36,000
American Smelting & Refining Co.	El Paso, Tex.	4	400,000	12	740,000	4	800,000	4	88,000
American Smelting & Refining Co.	Garfield, Utah	4	800,000	48	1,400,000	7	1,300,000	9	160,000
American Smelting & Refining Co.	Hayden, Ariz	—		12	660,000	4	580,000	4	47,000
American Smelting & Refining Co.	Matehuala, Mex.	4	400,000	—	—	—			
American Smelting & Refining Co.	Monterry, Mex.	1	80,000	—	—	—		—	—
American Smelting & Refining Co.	Omaba, Neb.	—	—	—	—	—		2	—
American Smelting & Refining Co.	Perth Amboy, N. J.	1	90,000	—	—	—		3	11,000
American Smelting & Refining Co.	Tacoma, Wash.	5	700,000	6	274,000	1	200,000	4	44,000
American Smelting & Refining Co.	Velardeña, Mex.	3	250,000	—	—	—		—	
Anaconda Copper Mining Co.	Anaconda, Mont	4	1,600,000	95	2,380,000	9	1,980,000	7	405,000
Anaconda Copper Mining Co.	Great Falls, Mont.	5	800,000	18	290,000	2	210,000	2	49,000
Arizona Copper Co.	Clifton, Ariz.	—		8	220,000	3	270,000	4	15,000
Arizona Copper Co.	Clifton, Ariz. (b)	2	400,000		—	—	—	2	6,000
Arizona Smelting & Power Co. (c)	Benson, Ariz.	1	54,000	—	—		—	—	—
Cie du Boleo (h)	Santa Rosalia, Mex.	7	700,000	—	—	—	—	—	—
British America Nickel Corp. (d)	Nickelton, Ont.	2	480,000	—	—	—	—	3	408,000
Calaveras Copper Co.	Copperopolis, Cal.	1	70,000	—	—	—	—	—	—
Calumet & Arizona Mining Co.	Douglas, Ariz.	2	620,000	24	788,400	5	1,050,000	5	104,000
Canada Copper Corp. (c)	Greenwood, B.C.	3	912,000	—	—	—	—	2	52,000
Cananea Consol. Copper Co. S. A.	Cananea, Mex.	8	1,198,000	12	219,000	2	276,000	6	91,000
Consolidated Arizona Smelting Co.	Humboldt, Ariz.	1	100,000	4	140,000	1	200,000	3	12,000
Consolidated Mining & Smelting Co.	Trail, B. C.	4	710,000	—	—		—	2	36,500
Democrata Cananea Sonora Copper Co	Cananea, Mex.	3	320,000	—	—	—	—	1	5,800
Douglas Mountain Copper Mines Co. (c).	Near Sunbeam, Col.	—	—	—	—	1	11,000		
Ducktown Sulphur, Copper & Iron Co.	Isabella, Tenn.	1	180,000		—		—	—	—
East Butte Copper Mining Co.	Butte, Mont.	2	225,000	—	—	—	—	4	5,000
El Fuerte Mining & Smelting Co. (c)	Choix, Sinaloa, Mex.	1	36,000	—	—	—	—	—	—
Granby Consolidated M. S. & P. Co.	Anyox, B.C.	4	1,642,000	—	—	—	—	4	50,000
Granby Consolidated M. S. & P. Co. (h)	Grand Forks, B.C. (c)	8	1,400,000	—	—	—	—	3	
Greene Cananea Copper Co. (e)			—		—	—	—	—	—
International Nickel Co.	Copper Cliff, Ont	8	1,350,000	4	170,000	1	190,000	6	75,000
International Smelting Co.	Miami, Ariz.	—	—	10	1,095,000	4	875,000	5	50,000
International Smelting Co.	Tooele, Utah	—	—	32	500,000	5	500,000	5	50,000
Ladysmith Smelting Corp. (c) (h)	Ladysmith, B. C.	2	236,000	—	—	—	—	—	—
Mason Valley Mines Co. (f)	Thompson, Nev.	2	419,000	—	—	—	—	2	28,000
Mazapil Copper Co.	Concepcion del Oro, Mex.	4	278,000	—	—	—	—	—	
Cia. Metalurgica Mexicana	San Luis Potosi, Mex.	1	72,000	—	—	—	—	—	
Cia. de Minas de Mexico, S. A. (c)	Mina Mexico, Sonora, Mex	1	17,000	—	—	—	—	—	
Missouri Cobalt Co.	Fredericktown, Mo.	2	40,000	3	—	—	—	—	
Mond Nickel Co.	Coniston, Ont.	4	800,000	—	—	—	—	4	100,000
Mountain Copper Co.	Mococo, near Martinez, Cal.	—	—	3	18,000	3	100,000	3	10,000
Nevada Consolidated Copper Co.	McGill, Nev.	—	—	20	600,000	5	900,000	4	20,000
Nichols Copper Co.	Laurel Hill, N. Y.	1	100,000	—	—	—	—	4	—
Norfolk Smelting Co.	West Norfolk, Va.	1	87,500	—	—	—	—	2	5,250
Old Dominion Co.	Globe, Ariz.	3	400,000	—	—	—	—	1	40,000
Ouray Smelting & Refining Co.	Ouray, Col.	2	164,250	—	—		—	—	—
Penn Mining Co.	Campo Seco, Cal.		—	9	73,000	2	91,000	1	137,000
Phelps Dodge Corp., Copper Queen Branch	Douglas, Ariz.	10	1,700,000	24	600,000	3	600,000	7	91,000
Phelps Dodge Corp., Morenci Branch	Morenci, Ariz.	1	193,000	—	—	—	—	3	10,000
Tennessee Copper Co. (h)	Copperhill, Tenn.	5	1,000,000	—	—	—		2	15,000
Teziutlan Copper Mng. & Smg.	Teziutlan, Puebla, Mex.	2	328,000	—	—	—		2	—
Cia. Metalurgica de Torreon	Torreon, Coahuila, Mex.	1	55,000	—	—	—	—	1	2,000
U. S. Metals Refining Co. (g)	Chrome, N. J.	2	200,000	—		—	—	3	—
U. S. Smelting, Ref. & Mng. Co. Mammoth Pl't	Kennett, Cal.	3	450,000	—	—	—	—	2	11,000
United Verde Copper Co.	Clarkdale, Ariz.	4	1,000,000	12	450,000	3	700,000	5	—
United Verde Extension Mining Co.	Verde, Ariz.	1	255,500	6	273,750	2	365,000	3	—
Western Smelting & Power Co.	Cooke, Mont.	1	109,500	—	—	—	—	—	—

(a) Not used. (b) Formerly owned by the Shannon Copper Co. (c) Not in operation in 1919. (d) Expect to begin smelting in January, 1920. (e) See Cananea Consolidated Copper Co. (f) Closed down March 1, 1919. (g) Owned by the American Metal Co. (h) Company did not furnish 1919 figures.

LAKE SUPERIOR SMELTING WORKS.

		[illegible]		[illegible]	
		No.	Annual Capacity	No.	[illegible]
Calumet & Hecla Mining Co. (a)	Hubbell, Mich.	1	[illegible]	[illegible]	[illegible]
Lake Superior Smelting Co. (a)	Dollar Bay, Mich	1	50,000	[illegible]	[illegible]
Michigan Smelting Co.	Houghton, Mich.	1	[illegible]		[illegible]
Quincy Smelting Works	Hancock, Mich	1	25,000		[illegible]

(a) Company did not furnish 1919 figures.

ELECTROLYTIC COPPER REFINERIES.

		1916 Capacity Pounds	1917 Capacity Pounds	1918 Capacity [illegible]	1919 Capacity [illegible]
American Smelting & Refining Co	Baltimore, Md.	600,000,000	720,000,000	[illegible]	720,000,000
American Smelting & Refining Co	Maurer, N. J.	240,000,000	288,000,000	[illegible]	[illegible]
American Smelting & Refining Co	Tacoma, Wash.	130,000,000	204,000,000	[illegible],000	204,000,000
Anaconda Copper Mining Co. (old plant)	Great Falls, Mont.	65,000,000	65,000,000	[illegible]	[illegible]
Anaconda Copper Mining Co. (new plant)	Great Falls, Mont.	180,000,000	180,000,000	180,000,000	[illegible]
Balbach Smelting & Refining Co.	Newark, N. J.	48,000,000	48,000,000	48,000,000	[illegible]
British America Nickel Co. (a)	Deschene, Que.	—		—	—
Calumet & Hecla Mining Co.	Hubbell, Mich.	65,000,000	65,000,000	65,000,000	65,000,000
Consolidated Mining & Smelting Co.	Trail, B. C.	8,400,000	14,000,000	14,000,000	(b)
Nichols Copper Co.	Laurel Hill, N. Y.	450,000,000	500,000,000	500,000,000	500,000,000
Raritan Copper Works	Perth Amboy, N. J.	460,000,000	460,000,000	460,000,000	460,000,000
U. S. Metals Refining Co.	Chrome, N. J.	250,000,000	250,000,000	250,000,000	250,000,000
Totals					

(a) New refinery to be in operation in 1920; capacity 15,000,000 lb. nickel, 8,000,000 lb. copper. (b) Company did not furnish 1919 figures.

nace not in operation, and the Calaveras Copper Co., now operating one blast-furnace one shift a day. A complete list of the copper smelters would include many other plants, most of them in Mexico, but many of them are small and require considerable repairs, so are not given here.

The Sasco plant of the American Smelting & Refining Co. is being dismantled. The Greenwood plant of the Canada Copper Corporation is permanently shut down so far as that company is concerned, a statement which also applies to the Grand Forks plant of the Granby company. The Shannon Copper Co., which operated a decrepit smelter at Clifton, Arizona, has sold its property to the Arizona Copper Co., and the furnaces are not in operation.

The number of roasting furnaces has been included in this year's list, as, with the progress in reverberatory smelting, more attention is being paid to this branch of metallurgy. The capacity of the roasting furnaces varies greatly, of course, owing to variations in size and in the work done, a statement which applies to all of the capacity figures given.

Capacities include the tonnage of all solid material charged to the furnaces with the exception of fuel, and represent the total amount which could be smelted if all furnaces operated at the normal rate. Capacities are given in short tons.

Eleven smelters have a capacity of 1,000,000 tons per year. Those with capacities of more than a million and a half tons rank as follows: (1) Anaconda, at Anaconda, (2) American Smelting & Refinery, Garfield Works, (3) Copper Queen, at Douglas, (4) Calumet and Arizona, at Douglas, (5) Granby, at Anyox, (6) International Nickel, at Copper Cliff, (7) Cananea, (8) United Verde.

The Lake Superior smelting works are reported separately, as they treat native copper ores.

The electrolytic copper refineries have not been enlarged, and no changes are contemplated during 1920. The refinery of the British America Nickel Co. has been built during the past year and should be in operation in 1920. Both electrolytic copper and nickel will be produced. It is probable that the British Government, which controls this company, will employ the nickel largely for coinage purposes.

Silver-Lead Smelters in North America. The *Engineering and Mining Journal* for January 17 gives particulars of silver-lead smelting works in North America.

N[illegible] and C[illegible] of Furna[illegible]
Lead-Smelting Works of North America.

United States.	No.	Annual Capacity
American Smelt. & Ref. Co., Denver, Col.	7	510,000
American Smelt. & Ref. Co., Durango, Col.	4	[illegible]
American Smelt. & Ref. Co., East Helena, Mont	4	330,000
American Smelt. & Ref. Co., El Paso, Tex.	6	380,000
American Smelt. & Ref. Co., Leadville, Col.	8	510,000
American Smelt. & Ref. Co., Murray, Utah	[illegible]	700,000
American Smelt. & Ref. Co., Omaha, Neb.	[illegible]	82,000
American Smelt. & Ref. Co., Perth Amboy, N.J.	[illegible]	170,000
American Smelt. & Ref. Co., Pueblo, Col.	7	380,000
American Smelt. & Ref. Co., Selby, Cal.	3	210,000
Bullshead Mining & Smelting Co., Spruce Mtn., Nev.	1	11,000
Bunker Hill & Sullivan M.&C. Co., Kellogg, Idaho.	3	300,000
International Smelting Co., Tooele, Utah	5	600,000
Northport Smelt. & Refining Co., Northport, Wash	2	216,000
Ohio & Colorado Smelting & Ref. Co., Salida, Col.	4	360,000
Pennsylvania Smelting Co., Carnegie, Pa.	2	60,000
U.S. Smelting, Ref. & Mng. Co, Midvale, Utah	7	530,000
Totals, United States	77	5,559,000
Mexico.		
American Smelt. & Ref. Co., Aguascalientes	1	50,000
American Smelt. & Ref. Co., Chihuahua	7	400,000
American Smelt. & Ref. Co., Monterrey, N.L.	7	410,000
American Smelt. & Ref. Co., Velardena	3	150,000
Mazapil Copper Co., Saltillo, Coahuila	3	105,000
Cia. Metalurgica Mexicana, San Luis, Potosi	10	360,000
Cia. de Minerales y Metales (a), Cerralvo, N.L.	2	38,000
Cia. de Minerales y Metales (b) Guadalupe, N. L.	1	77,000
Cia. Fundidora y Afinadora de Monterrey (c), Monterrey, N.L.	4	238,000
Cia. Minera de Penoles (d), Mapimi, Dur.	6	310,000
Cia. Metalurgica de Torrean (d) (e), Torreon, Coah.	8	286,000
Totals, Mexico	52	2,421,000
Canada.		
Consolidated Mining & Smelt. Co., Trail, B.C.	4	220,000

(a) Not in operation since Jan. 23, 1919. (b) Not in operation in 1919. (c) Smelter under lease to Cia. de Minerales y Metales. (d) Subsidiary of Cia. de Minerales y Metales. (e) Not in operation since Feb. 1919.

Zinc Smelters in United States.—The *Engineering and Mining Journal* for January 17 gives a list of zinc smelters in the United States, which is reproduced on the next page.

The production of electrolytic zinc in the United States in 1919 was 25,962 tons, compared with 38,885 tons in 1918 and 27,245 tons in 1917. The American producers were the Anaconda, River Smelting & Refining Co., Judge Mining & Smelting Co., and the Mammoth plant. All of these works were inactive at the end of 1919, but preparations were being made by the Anaconda and Judge companies to restart. The Consolidated Mining & Smelting Co. at Trail, B.C., produced 12,520 tons in 1919, 12,574 tons in 1918, and 9,956 tons in 1917.

ZINC-SMELTING CAPACITY OF THE UNITED STATES.

	Number of Retorts at End of Years	
	1918	1919
American Spelter Co. (a), Pittsburg, Kan.	896	896
American Steel & Wire Co , Donora, Penn	9,120	8,208
American Zinc & Chem. Co., Langeloth, Penn..	7,296	7,296
American Zinc Co. of Ill , Hillsboro, Ill	4,864	4,864
American Zinc, Lead and Smg. Co., Caney, Kan.	(e)6,080	6,080
American Zinc, Lead & Sm. Co., E. St. Louis, Ill.	5,620	5,620
Arkansas Zinc & Smg. Corpn., Van Buren, Ark.	3,200	3,200
Athletic Min. and Smelting Co., Fort Smith, Ark.	2,496	2,496
Bartlesville Zinc Co., Bartlesville, Okla.	7,488	5,184
Bartlesville Zinc Co., Blackwell, Okla.	9,600	9,600
Bartlesville Zinc Co., Lanyon-Starr, Bartlesville, Okla.	3,456	3 456
Eagle-Picher Lead Co., Henryetta, Okla.	4,000	4,000
Eagle-Pilcher Lead Co., Hillsboro, Ill.	(b)	3,200
Edgar Zinc Co., Cherryvale, Kan.	5,040	4,984
Fort Smith Spelter Co., Fort Smith, Ark.	2,560	2,560
Grasselli Chemical Co., Clarksburg, W. Va	5,760	5,760
Grasselli Chemical Co., Meadowbrook, W. Va	8,520	8,400
Grasselli Chemical Co., Terre Haute, Ind.	4,200	4,200
Hegeler Zinc Co., Danville, Ill.	5,400	5,400
Illinois Zinc Co., Peru, Ill.	5,440	5,520
Kusa Spelter Co., Kusa, Okla.	5,360	5,360
Lanyon Smelting Co. (a), Pittsburg, Kan.	448	448
Robert Lanyon Zinc and Acid Co., Hillsboro, Ill.	3,200	(b)
Matthiessen & Hegeler Zinc Co , La Salle, Ill	6,168	6,132
Mineral Point Zinc Co., Depue, Ill.	9,068	9,068
National Zinc Co., Bartlesville, Okla	4,160	4,256
National Zinc Co., (c), Springfield, Ill	4,480	4 480
New Jersey Zinc Co. of Penn., Palmerton, Penn.	7,200	7,192
Newkirk Smelter Co , Newkirk, Okla	(g)	(h)
Oklahoma Spelter Co. (a), Kusa, Okla.	1,600	1,600
Owen Spelter Co. (d), Caney, Kan.	1,920	(d)
Pittsburg Zinc Co., Pittsburg, Kan.	910	(g)
Prime Western Spelter Co., Iola, Kan.	1,972	2,320
Quinton Spelter Co., Quinton, Okla.	2,016	2,016
Sandoval Zinc Co., Sandoval, Ill.	672	336
Tulsa Fuel and Manufacturing Co., Collinsville, Okla.	6,232	6,232
United States Smelting Co. (f), Checotah, Okla..	5,120	5,120
United States Zinc Co., Henryetta, Okla.	3,448	3,448
United States Zinc Co., Sand Springs, Okla.	7,560	6,680
United States Zinc Co , Pueblo, Colo.	2,208	2,208
United Zinc Smg. Corpn., Moundsville, W. Va.	1,728	1,728
United Zinc Smg. Corpn. (f), Clarksburg, W. Va..	3,648	3,648
Weir Smelting Co. (a), Caney, Kan.	(d)	1,280
Weir Smelting Co.. (a), Weir, Kan.	448	448
	180,602	174,924

(a) Idle 1918 and 1919. (b) Plant of Robert Lanyon Zinc & Acid Co. was taken over by Eagle-Picher Lead Co. in July, 1919. (c) Idle 1919. (d) The Owen Spelter Co. works at Caney was taken over by Weir Smelting Co. in 1919. (e) Part of the American Zinc, Lead & Smelting plant at Caney, Kan., is leased to the Weir Smelting Co. (f) Idle latter part of 1918 and all of 1919. (g) Pittsburg Zinc Co. plant at Pittsburg, Kan., was purchased in 1919 by Newkirk Smelter Co., and moved to Oklahoma. (h) No report received.

Calcium Cyanide.—In *Chemical and Metallurgical Engineering* for February 11, W. S. Landis gives some particulars of the calcium cyanide now being supplied by the American Cyanamide Company for use in gold and silver metallurgy. This is a low-grade material containing many impurities, but its cyanogen is stated to be as effective as that in high-grade cyanides and the presence of the impurities is said to give rise to no inconvenience. The method of production is to heat a mixture of cyanamide of lime and common salt at high temperatures in an electric furnace, and the process was tried first in Germany fifteen years or more ago, though without commercial success. In 1916, when cyanide became scarce in America, the Cyanamide Company determined to try this German process, with the results given by Mr. Landis.

The development of the industry has been rapid. In 1917 there was produced approximately 2,187,000 lb. equivalent of 100% sodium cyanide. In 1918 this grew to 2,350,000. In 1919 a very considerable revision of the process and equipment was made, and as a consequence the plant operated only seven months, during which period it produced at the rate of over 4,000,000 lb. of NaCN per year. The quality of the product started at about 14% equivalent sodium cyanide in January, 1917, and in August, 1919, ran uniformly between 36 and 37% equivalent sodium cyanide. Material running as high as 50% equivalent sodium cyanide has been produced and there have been shipped several carloads running around 45%.

The process and apparatus used for manufacturing this product have been extensively described in the many United States and foreign patents covering the process. According to present practice, cyanamide, salt, and calcium carbide are mixed together and continuously fed to a single-phase furnace designed so that it has a very small cubical capacity as compared with the power input. Melting is extremely rapid and the fused product is removed from the furnace almost continuously to a cooling device, which instantly chills the product. This is necessary to prevent reversion of the initial reaction. The proportions of cyanamide and salt vary with the product to be made. In 1917 operations were started with two parts of salt to one part of lime nitrogen and gradually decreased in salt content until, in making the present standard 36 to 37% product, more cyanamide than salt is being used.

The resulting product is marketed in the form of small thin scales of a greyish black to shiny black appearance, and the standard grade, known as Aëro Brand Cyanide "Grade X," contains between 36 and 37% equivalent sodium cyanide. This method of expressing its composition is used because it is sold on the basis "per lb. of sodium cyanide equivalent." A complete analysis of the material has so far proved impossible of execution, but evidence points to the fact that it consists of a mixture of calcium cyanide, sodium chloride, and free lime, with fractions of a per cent each of calcium carbide, calcium cyanamide, and other minor impurities obtained from the ash of the coke used in cyanamide manufacture. The product known as Aëro Brand Cyanide "Grade XX" contains about 45% equivalent sodium cyanide—the cyanogen being actually present as calcium cyanide—a slightly higher percentage of free lime and a materially lower percentage of salt than the X grade.

As to the use of this material, it has been well received by the mining industry. Being made from cyanamide, one of the cheapest forms of combined nitrogen, and common salt, its cost of manufacture and its selling price are materially less than the purer forms of cyanide hitherto on the market.

The first of this cyanide made in 1917 went into the precious metal industry after a short series of laboratory tests, in which it was demonstrated that it would dissolve gold and silver with equal efficiency to the 98% grade then in the market, and that the accumulation of soluble salts due to the cyclical use of solutions in the mill would not prove troublesome. In mill operations the drums were opened and the cyanide placed in a revolving tumbler which dissolved it in water, thus giving an opportunity for any acetylene produced to be evolved outside of the mill solutions. Containing as it does a small amount of insoluble material, part of which is carbon, difficulty with precipitation due to the presence of this carbonaceous material was feared, and the solutions were therefore filtered before passing into the mill circuit. Experimental work quickly determined that the carbonaceous residue had no precipitating effect upon cyanide solutions of the precious metals, and this early practice of presolution was quickly abandoned, and from then to the present time the new cyanide is dumped directly into the mill circuit.

The small amount of sulphur present in the cyanamide is carried through into the cyanide as a sulphide. Difficulty was feared with the presence of this sulphide, but experience has shown that the aëration employed in the cyanide mills quickly oxidizes these sulphur compounds and renders them harmless. As a result no trouble has been experienced from its sulphur content.

SHORT NOTICES.

Mechanical Loaders.—In the *Engineering and Mining Journal* for January 31, A. M. Gow describes many new machines for loading ore into cars underground.

Turbine Pumps.—The *Engineer* for February 27 publishes a description of a multi-stage high-pressure turbine pump made by Mather & Platt. There are two pumps, mounted one on each side of the electro-motor; the low-pressure pump has six impellers and develops 1,486 ft. head, and the high-pressure pump has eight impellers and raises the head to 3,470 ft. It runs at 1,480 r.p.m., and is driven by a motor rated at 1,450 h.p.

Air-Compressor Drive.—The *Colliery Guardian* for March 5 and 12 contains a translation of an article by A. Dessemond, appearing in the Bulletin de la Société de l'Industrie Minerale, describing the application of exhaust steam from winding-engines to operate turbines driving air-compressors.

Liquid Air for Blasting.—The *Iron & Coal Trades Review* for March 5 describes the application of liquid air as an agent for blasting, as adopted at the Kladno coal mines, Bohemia.

Pumping by Air-Lift.—*Mining and Metallurgy* for February contains a paper by S. F. Shaw describing the unwatering of the Tiro General, Charcas, San Luis Potosi, Mexico, by means of the air-lift.

Drills for Oil-Wells.—In the *Engineering and Mining Journal* for February 7, A. G. Wolf describes rotary rock-bits used in drilling oil-wells.

Aerial Ropeways.—In the *Engineering and Mining Journal* for February 28, Douglas Lay writes on the design and arrangement of aerial ropeways, having regard particularly to various methods of prolonging the life of the ropes.

Rennerfelt Electric Furnace.—In *Chemical and Metallurgical Engineering* for February 11, H. A. de Frees describes the Rennerfelt electric reverberatory furnace.

Pulverized Fuel.—*Mining and Metallurgy* for February contains a paper by R. E. H. Pomeroy describing the coal-pulverizing plant at the Nevada Consolidated copper reverberatory furnaces.

Volatilization in Assaying.—*Mining and Metallurgy* for February contains a paper by F. P. Dewey, assayer to the United States Mint, on volatilization in assaying.

Blast-Furnace Gas.—At the March meeting of the Institution of Electrical Engineers, S. H. Fowles read a paper on the production of power from blast-furnace gas.

Lithopone. — In *Chemical and Metallurgical Engineering* for March 17, Chester H. Jones describes the manufacture of lithopone, a white pigment composed of zinc-sulphide and barium sulphate, at the old zinc-smelting works at Collinsville, Illinois, belonging to the Collinsville Zinc Corporation. The zinc ore comes from the company's Lost Hill mines at Moselle, Missouri.

Cyanide Processes.—*Chemical and Metallurgical Engineering* for February 18 contains a reprint of a paper by Herbert Philipp, read before the American Electrochemical Society, reviewing recent methods of producing cyanide.

Metallurgy at Connemara Mine.—The January issue of the *Journal* of the Chemical, Metallurgical, & Mining Society of South Africa contains a paper by B. L. Gardner describing the method of gold metallurgy at the Connemara gold mine, Rhodesia. The ore is oxidized banded ironstone. Extraction is improved by subjecting the ore to a low heat, called "baking," before cyanidation.

Asia Minor.—In the *Engineering and Mining Journal* for January 21, I. [illegible] on the mining possibilities of Asia Minor, Mesopotamia, and Palestine.

Tungsten Ores in China.—The *Engineering and Mining Journal* for January 31 contains a brief article by Robert Slessor describing the tungsten ore districts of South China.

Ouro Preto Gold Mines.—At the March meeting of the Cornish Institute of Engineers, Maurice Gregory read a paper describing the Passagem gold mine worked by the Ouro Preto Gold Mines of Brazil.

Tin in Australia.—*Chemical Engineering and Mining Review* (Melbourne) for January contains a comprehensive article by J. B. Lewis on tin mining in Australia, giving particular reference to operations in Tasmania.

Upper Silesia.—In the *Engineering and Mining Journal* for February 7, J. E. Orchard writes on the mineral wealth of Upper Silesia, the possession of which is being determined by instruction of the Peace Conference.

Petroleum in the Argentine.—*Mining and Metallurgy* for February contains a paper by S. C. Herold on the chances of oil discovery in the Argentine.

Petroleum in the Philippines.—*Mining and Metallurgy* for February contains a paper by W. D. Smith on the possibilities of oil production in the Philippine Islands.

Mogollon, New Mexico.—*Mining and Metallurgy* for February contains a paper by D. B. Scott describing the Mogollon silver district, New Mexico.

Earth and Rock Pressures.—*Mining and Metallurgy* for February contains a paper by H. G. Moulton, a civil engineer, on earth and rock pressures, containing advice regarding the stability of open-cut workings at the porphyry copper mines and at frozen placers.

Brannerite.—*The Journal of the Franklin Institute* for February contains an article by F. L. Hess and R. C. Wells describing a new uranium mineral found in the Stanley gold placers in Idaho. This has been called "brannerite," after Dr. J. C. Branner, formerly head of the department of geology and mining at Stanford University. Its composition is determined as a complex titanate of uranium with smaller quantities of rare earths and other metals.

RECENT PATENTS PUBLISHED.

☞ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.2., with a note of the number and year of the patent.*

13,878 of 1914. O. WAUTHIER, Brussels. A grinding machine consisting of a rotating cylinder in which there are a number of small rotating rollers.

3,369 of 1918 (139,229). C. GIESECKE, Bad Harzburg, Germany. Sintering fine ores in a vertical shaft furnace.

8,535 of 1918 (138,946). S. FIELD and the METALS EXTRACTION CORPORATION, London. Removing objectionable metals from zinc solutions before electrolysis by treatment with ozonized air in presence of an oxide or carbonate of a metal such as manganese.

8,831 of 1918 (138,947). H. L. SULMAN, S. FIELD, and the METALS EXTRACTION CORPORATION, London. Using a temperature of 80 to 100°C for precipitating nickel from zinc sulphate solutions by means of zinc dust.

8,832 of 1918 (138,948). H. L. SULMAN, S. FIELD, and the METALS EXTRACTION CORPORATION, London. Removing cobalt from zinc sulphate solutions by treating with a mixture of manganese and lead oxides at a temperature of from 80 to 100°C.

10,708 of 1918 (138,950). S. FIELD and the METALS EXTRACTION CORPORATION, London. Precipitating nickel, cobalt, and other metals from zinc sulphate solution by the action of amalgamated zinc or amalgamated aluminium.

18,475 of 1918 (138,387). E. HELME, Leeds. Improved motion of jaw in ore-breakers.

18,832 of 1918 (138,954). S. FIELD and the METALS EXTRACTION CORPORATION, London. In precipitating nickel and other metals from zinc sulphate solution by action of zinc dust, the addition of some free acid to the solution.

212 of 1919 (139,247). GENERAL ELECTRIC CO., Schenectady, New York. Improvements in the alumino-thermic process for reducing refractory metals from their oxides.

1,731 of 1919 (138,406). H. W. MATHESON, Shawinigan Falls, Quebec. Electrolytic cell for oxidizing mercury.

2,213 of 1919 (138,411). W. C. KIRBY and E. L. LAKIN, Leamington. Using flat perforated discs instead of pebbles or balls in tube-mills.

2,289 of 1919 (129,621). H. LUNDBERG and H. NATHORST, Stockholm. Improvements in electric apparatus for discovering mineral lodes.

2,690 of 1919 (138,693). W. H. FEARN, Doncaster. Improved method of laying mine rails with the object of obtaining more head-room for the cars.

4,474 of 1919 (138,443). HUNTINGTON, HEBERLEIN & CO., and H. C. BINGHAM, London. Improvements in multiple-hearth roasting furnaces, having for their object the more efficient heating of the lowest hearth.

4,847 of 1919 (139,005). K. J. P. ORTON and G. W. ROBINSON, Bangor. Method of precipitating iron from sulphate of alumina in the course of producing an alumina free from iron.

6,282 of 1919 (139,314). F. E. WALKER and J. B. BETTS, Mansfield. Improved method of fitting parts of reinforced concrete for lining shafts, etc.

6,329 of 1919 (138,466). R. FORSYTH, Hancock, Michigan. In pulverizing machines, using surfaces consisting of soft metal in which are embedded fine particles of hard material.

6,739 of 1919 (138,472). SOCIETE DE VEDRIN and J. MARCOTTY, Vedrin, Belgium. A horizontal rotating cylindrical furnace for roasting zinc blende for acid production.

8,152 of 1919 (138,486). F. B. SCHROFF, Gwalior, India. Method of producing barium chloride from barytes.

9,110 of 1919 (138,493). A. SCHOTT, Strasbourg, France. Telescopic wooden pit props.

10,169 of 1919 (139,065). JUNZO HISAMOTO, Nagoya, Japan. Method of drawing refractory metals into wire for incandescent electric lamps.

12,827 of 1919 (127,260). P. C. A. ROTTELEUR, Paris. Method of pumping petroleum from great depths through narrow tubes.

16,240 of 1919 (139,390). A. R. PECK, Los Angeles, California. Improved method of mounting filter leaves.

18,644 of 1919 (138,032). G. H. T. RAYNER, and P. RAYNER, Sheffield. Valves for rock-drills. Claims: (1) Valves for rock-drills and like percussive tools characterized by an enlarged central collar with a perforated collar on either side, said collars controlling three annular grooves each connected with the exhaust outlet, and providing a large exhausting capacity for a relatively short valve travel. (2) In valves for rock-drills and like percussive tools as claimed in Claim (1), the alternative construction in which the central collar is of such a width that it can span one of the annular exhaust grooves and in which four annular exhaust grooves are provided, all being in communication with the exhaust outlet. (3) Valves for rock-drills and like percussive tools, constructed, arranged, and operating so as to give a large exhausting capacity for a relatively short valve travel.

18,645, 24,420, 26,452, and 28,821 of 1919 (138,556, 138,576, 138,577, and 138,304). G. H. T. RAYNER and P. RAYNER, Sheffield. Improvements in valves of rock drills.

19,486 of 1919 (130,994). H. MULLER, Düsseldorf. Hinged pit props.

23,375 of 1919 (138,291). P. L. DATTA, Calcutta. Extracting iodine by mixing alkali iodide with chrome ore and treating with air and steam, thus releasing iodine and forming an alkali chromate.

28,471 of 1919 (139,443). COMPAGNIE DES PRODUCTS CHIMIQUES D'ALAIS ET DE LA CAMARGUE, Paris. Precipitating copper and cadmium from zinc sulphate solutions by placing plates of copper and zinc in the solutions, the copper and cadmium being precipitated on the copper plate.

NEW BOOKS, PAMPHLETS, Etc.

Manganese Ores in New Mexico. By Edward L. Jones. Bulletin 710 B of the United States Geological Survey. This pamphlet gives details of manganese iron ore deposits that have recently been developed.

South African Mining & Engineering Journal's Special Coal Number. Price 2s. 6d. This issue of our South African contemporary is devoted to descriptions of the coal resources of the Sub Continent.

South African Currency and Exchange Problem. By Henry Strakosch, chairman of the Union Corporation, Ltd., Johannesburg; Central News Agency, Ltd. This pamphlet contains several suggestions with regard to the issue of "Treasury Gold Certificates" against gold deposited.

Handbook of Commercial Information for India. By C. W. E. Colton, Collector of Customs, Calcutta. Published by the Government of India Department of Commerce and Industry. London office: 60, Winchester House, E.C.2. The object of this book is to give a general review of the foreign trade of British India.

West African Market Handbook, 1920. Compiled by Hubert A. Meredith. 153 pages, pocket size. Price 3s. 6d. London: Purbrook & Eyres, 96a, Old Street. This book sets out the position of the gold and tin-mining companies whose shares are known in the West African section of the London Stock Exchange. Statistics include the financial results and also the monthly metal returns for several years of the chief producers.

Mining in Malaya.—The Malay States Information Agency, 88, Cannon Street, London, E.C.4, has published another edition of the pamphlet of this name. It contains contributions from F. J. B. Dykes, late Senior Warden F.M.S., and W. Eyre Kenny, present Senior Warden. F. Douglas Osborne writes on hydraulic mining, M. A. Francis on the Pahang Corporation's tin lodes, and Henry Brelick on mining in Trengganu. Reginald Pawle provides a preface.

The African World's Victory & Peace Annual. Price 3s. 6d. net. London: 801, Salisbury House, E.C.2. Edited by Leo Weinthal. The yearly issue of the *African World* is full of interesting reading relating to the trade and resources of South Africa. Over three hundred pages, foolscap size, closely printed and well illustrated, afford plenty of reading of an informative character. The portraits of South African notabilities, with particulars of their careers, give a personal touch which is very attractive.

COMPANY REPORTS

Plymouth Consolidated Gold Mines.—Six years ago this company was formed in London to take over from the California Exploration Company the Plymouth Consolidated group of mines situated on the Mother Lode, in Amador County, California. Ore treatment commenced in August, 1914, and dividend payments started in 1915. The report for 1919 shows that rather less ore was milled than in 1918 (119,700 tons against 125,300 tons), but the grade was higher (24s. 11d. per ton against 22s. 11d. per ton), and the yield was £148,666 compared with £143,686. The increase in gross revenue, however, was more than offset by the expansion in working costs, which were 2s. 9d. per ton higher, so that the net profit was about £5,000 lower at £24,425. Two dividends of 1s. per share were paid for the period under review, the rate being the same as for the two preceding years. The report of the general managers (Bewick, Moreing & Co.) states that although the local management succeeded in obtaining the number of men required the standard of efficiency was not quite maintained. The yield from the 119,200 tons milled was 34,526 oz. gold and 7,940 oz. silver. The amount of development work performed last year was 6,176 ft. or only slightly less than in the previous twelvemonth, but a considerable part of it was directed to prospective operations, and owing to the delay in sinking the shaft, caused by the necessity of repairing certain sections where the ground was abnormally heavy, a smaller tonnage of payable ore was opened up than in 1918. No ore reserves estimate is published. At the lowest level (2,750 ft.) the north foot-wall ore-shoot is reported to have been met and proved so far for a length of 70 ft., averaging 46s. 6d. per ton over a width of 62 in. W. A. Macleod has joined the board of directors of the company in the place of the late David Richards.

San Francisco Mines of Mexico.—The option granted in August, 1919, to an American group to purchase for 3½ million dollars the group of silver, gold, lead, and zinc mines in the State of Chihuahua owned by this company (and formerly by the San Francisco del Oro Mining Co.) having been abandoned, the provision of fresh capital to enlarge the plant and develop the property has been engaging the attention of the directors. In their report dated March 18, they ask for authority to increase the capital (now £650,000 nominal) to £800,000, and request the debenture-holders to sanction the further postponement, for one year, of payment of interest. The balance sheet at September 30 last shows that accrued interest then amounted to £68,100. During the early part of 1919 operations at the mine were conducted under serious difficulties owing to the conditions then existing in the district, and in May of that year it became necessary to close down the plant and withdraw the staff from the mine. In the latter part of September work at the mine was resumed, and the mill was re-started late in December. Labour shortage has prevented the mill being worked to its full capacity; otherwise its operation is reported to have been satisfactory. The present mill is designed to produce lead concentrates containing a large proportion of the silver contents of the ore. Knox & Allen report that the laboratory experiments for the production of zinc concentrates have progressed to the point which enables them to foresee ultimate success, but that these results must be confirmed by the pilot zinc plant now under construction before the final zinc plant can be designed. When the experimental work has reached the state of finality they recommend that a concentrating mill of 500 tons daily capacity should be provided for, the estimated cost being $400,000.

Mysore Gold.—This 40-year-old Indian mining enterprise—which has produced over 5 million ounces of standard gold and has declared dividends amounting to nearly nine millions sterling—recently doubled its capital, raising the nominal amount to £610,000 (in 10s. shares) in order to provide funds to push development retarded during the war period. The report of the directors for the year 1919 is not accompanied by the mine superintendent's annual statement, but extracts from the latter are incorporated in the former. From these we learn that a continuous and fair length of payable ore has been exposed at the 53rd level, Ribblesdale's section, and although developments of substantial importance in other sections of the mine cannot be pointed to, at several places throughout the deeper workings the lode has been proved to be worth over an ounce to the ton for appreciable distances, some being (according to the superintendent) enrichments beneath ore of very low grade. In McTaggart's section, at the 44th level south, ore averaging 2 ft. 6 in. in width and assaying 2 oz. 6 dwt. has been proved for a distance of 57 ft., and it is hoped that this rich patch is the top of a new pay-shoot. At the end of 1919 the ore reserves were estimated at 870,000 tons, or 40,000 tons less than a year earlier. In view of the increased working costs certain blocks of ore had to be excluded from the reserves. Last year 270,425 tons of ore was crushed for a total yield of 163,719 oz. of fine gold, which realized £694,317. In 1918 the yield from 293,186 tons realized £739,192. The working profit was £186,443. Income tax absorbed £66,189, expenditure on capital account written off £37,694, and £10,000 has been transferred to the reserve fund. The dividends for the year amount to 2s. per 10s. share and absorb £61,000, as against 4s. 6d. per share, absorbing £137,250, for 1918.

Barramia Mining & Exploration.—About the middle of 1909 this company was formed to acquire from the Egypt & Sudan Mining Syndicate a mining property situated in the desert between the Nile and the Red Sea. Crushing with 10 stamps was in progress to December, 1917, but the ordinary shareholders received only one dividend, namely, a distribution of 4% in September, 1912. The directors' report, now issued, states that by September last the whole of the dumps had been treated, and that all operations on the property had ceased. An offer of £1,597 for the plant and buildings was accepted. At December 31 last the company's liabilities amounted to £9,547, as against cash and debtors representing £2,581. The company is now to be liquidated.

Mount Morgan Gold Mining.—This Queensland enterprise has now been in existence nearly thirty-four years. The mine was originally worked for gold, but the company is now principally a copper producer. The report for the half-year ended November 30, 1919, shows that 90,475 tons of ore was smelted for a yield of 2,748 tons copper and 41,191 oz. gold. The total revenue from all sources was £495,981, and the surplus amounted to £93,333, of which £50,000, equal to 1s. per share, was distributed among the shareholders. Liquid assets at November 30, 1919, totalled £543,732 as against creditors for £127,646. With a view to obtaining more complete data as to leaching Mount Morgan ore a unit for the treatment of ten tons daily has been installed. The laboratory and one-ton unit gave satisfactory indications as to the recovery of copper but the gold extraction was not so completely and satisfactorily demonstrated. The general manager, A. A. Boyd, estimated the ore reserves at November 30 last at 3,538,204 tons containing 2·59% copper and 6·12 dwt. gold.

Brilliant Extended Gold Mining.—The original mine of this Charters Towers company, formed in 1895, was abandoned in August last, and the plant was sold. The directors have been considering the acquisition of property elsewhere, and the report for the half-year ended November 10, 1919, refers to a proposal to take a six months' option on a tin-mining lease in the Kangaroo Hills belt of country about 90 miles from Charters Towers. The board recommends the acceptance of the offer in view of the reports made by James B. Lewis and George Ross, and the fact of the property's proximity to the Sardine mine which is developing satisfactorily.

Kassa-Ropp Tin.—Formed in April, 1917, to acquire alluvial tin areas in Northern Nigeria, this company won 159 tons of concentrates up to the following June, and in the next twelve months 138 tons was obtained. The report for the year ended June 30, 1919, shows that the tin sold realized, after allowing for smelting charges, a gross price of £163. 12s. 6d. per ton, as compared with £218. 4s. in the previous period. The accounts show a profit of £6,743 subject to excess profits duty and income tax. Three dividends of 5% were paid, and on account of the current year a distribution of 10% less tax was paid on March 16. The company's mining and prospecting licences have since been sold to the Associated Nigerian Tin Mines for 200,000 fully paid shares of 5s. each, and the company exercised its right of subscribing for its portion of working capital shares at par. In addition to the cash dividend above mentioned, shareholders have been given the opportunity of taking 10,000 Kuru shares at 5s. per share in the proportion of one Kuru for every eight Kassa-Ropp shares held.

Fanti Consolidated Mines.—The present company, formed in 1909, is a reconstruction of a concern of the same name formed at the end of 1900. The original capital of £600,000 in 10s. shares was extended to £750,000 in August, 1909, but in March, 1918, 2s. per share was written off, representing depreciation on shares and other interests. In August last the company paid its first dividend (10d. per share). The report for 1919 shows a larger profit than was earned in the previous twelvemonth (£82,018 against £72,365), and the dividend is raised to 1s. 3d. per share, less tax. Besides National War Bonds, and debentures of the British South Africa Company, Chinese Engineering, and Wankie Colliery, the company holds a large number of West African mining shares, and interests in the Baluchistan Chrome, Rhodesia Chrome, Ropp Tin, and Mount Oxide mines. At the last annual meeting the chairman foreshadowed the formation of a company to acquire and work the West African manganese properties, but the report shows that the arrangements have been hung up owing to the attitude of the Inland Revenue authorities on the subject of excess profits duty. In 1919 the tonnage shipped from these properties was 35,113 tons. It is stated that a large increase in the output cannot be looked for while hand labour only is available.

South African Gold Trust.—The report for 1919 shows that the realized net profit, mainly derived from dividends on investments and interest on loans, amounted to £107,538, compared with £95,740 for 1918. The dividends declared for the past year total 2s. 6d. per share, free of tax, or 6d. per share more than was paid in respect of 1918. A sum of £76,796 remains to be carried forward. The report contains a list of the company's principal holdings at December 31, 1919. The list includes British Government Stocks, $518,800 preference stock and $772,200 common stock of the American Trona Corporation, 15,271 ordinary shares of the British Cyanides Co., 2,500 Burma Corporation shares, 24,927 preference shares of the Colombian Corporation, 23,167 Gold Coast Amalgamated, 22,000 Government Areas, 39,163 Knights Deep, 3,645 Mexican Corporation, 9,160 New Modderfontein, 62,505 Oroville Dredging, 12,621 Ropp Tin, 46,738 Simmer Deep (also blocks of debentures), 134,059 Simmer & Jack, and 92,295 common $5 shares of the South American Gold & Platinum Company.

Knight Central.—This low-grade Rand mine, which has been milling since January, 1909, made only a very small margin of profit last year, and this balance on the right side was entirely due to the sale of gold at a premium during the latter half of the period. The report for 1919 shows that 252,100 tons of ore was milled for a yield of £1. 9s. 11d. per ton, while working costs amounted to £1. 8s. 7d. per ton. The gold premium yielded 2s. 11d. per ton. The net profit was £18,574, as compared with £16,278 in 1918, when the gold won was sold at the normal rate. The report states that the average yield secured last year was the highest in the history of the mine, but working costs increased to the extent of 5s. per ton. Development work was again confined almost entirely to the Main Reef area on the 18th level east of the East shaft. This patch of ore, upon which the future of the mine so largely depends, has shown definite signs of impoverishment both in depth and laterally, the most advanced headings having been in unpayable ground for some time. They have consequently been stopped with the exception of one winze. The future depends chiefly on the magnitude and duration of the gold premium; with gold at the normal price the mine could not be operated without loss under present-day conditions.

Tweefontein Colliery.—This company was formed in 1907 by Henderson's Transvaal Estates to work the colliery on Tweenfontein Farm, in the Middelburg district of the Transvaal. In 1917 an amalgamation was effected with Tweefontein United Collieries, the arrangement being that Tweefontein Colliery should hold shares in United Collieries. The report for 1918 showed £8,250 received as dividends. Dividends of 10% on both preference and ordinary shares have been paid, absorbing £13,500. The report of United Collieries showed that influenza, strikes, and car shortage had combined to cause a fall in the output. As regards reserves, those at Tweefontein and Waterpan are estimated at 50 million tons best quality and 150 million tons second quality, while 7,500,000 tons of first-class coal remains to be mined at Oogies.

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CONTENTS.

EDITORIAL

THE Mineralogical Society has commenced the publication of "Mineralogical Abstracts." Those interested should communicate with Mr. L. J. Spencer, at the Mineral Department of the British Museum, South Kensington.

LEAD-mining in Yorkshire is the subject of an article in this issue, in which Mr. W. W. Varvill gives a clear account of what is being done at Greenhow, near Pateley Bridge. The success of enterprises of this character nowadays depends on the quality of the labour. An unusually interesting feature of the work at Greenhow was the service done in prospecting at depth by the construction of the Bradford aqueduct. The number and value of the veins cut while driving this deep tunnel provided encouragement to the mine-owner to persevere. This free testing at depth was naturally greatly appreciated.

STANDARDIZATION of petrographic nomenclature is exercising the attention of the Geological and Mineralogical Societies, and a committee of twelve distinguished mineralogists and geologists has been appointed to investigate the possibility of a move in this direction. We notice that this committee is to concern itself only with "British" nomenclature. It is a pity that the movement cannot include American habits of thought as well. One of the most serious obstacles to the spread of the study of ecomonic geology is the variation in the meaning of words, and the continual reapplication of old terms and the invention of unnecessary new ones. In reality, economic geology is not nearly so complex a subject as it appears at first sight. Both this science and colloid chemistry suffer from a confusion of definitions.

CAMBORNE Mining School has arranged a holiday course in geology, to occupy six weeks, from July 12 to August 23. This course is open to outsiders, and it can be recommended to all who desire to obtain an insight into economic geology, particularly in connection with Cornish rocks and minerals. The lectures will cover the following subjects Cornish granites and the associated igneous rocks; contact metamorphism of the granite area; changes produced by magmatic vapours and solutions; the structure and origin of the mineral veins; denudation in Cornwall and the formation of alluvial gravels. The laboratory work will include the study of a representative collection of Cornish rocks and veinstones, both in the hand specimen and under the microscope, and the examination and sizing of alluvial sands and dressing products. The field-work will include the construction of a geological map of a typical area, and excursions to places of geological interest, including Land's End, St. Austell, Porthleven, the Lizard, and East Pool, Castle-an-Dinas, and Great Perran mines. Any of our readers desirous of taking this course should communicate with Mr. Alex. Richardson, the principal of the School, or with Mr. E. H. Davison, the lecturer on geology.

IN recent issues we have referred in contemptuous vein to the Calloose lode and alluvial enterprise in the Gwinear district of Cornwall, promoted by Mr. Albert F. Calvert. The statutory meeting of shareholders, held on April 20, was notable for the chairman's announcements which effectually disposed of the statements contained in the prospectus. Three months ago we were told that two lode properties were producing tin at a profit, that the alluvials were yielding a profit at the rate of £45,000 per year, and that no working capital was required just now. The chairman at the meeting of shareholders omitted reference to the lode properties, he said that something had gone wrong with the alluvials, and that additional capital was required. In a brief paragraph in the April issue of the Magazine, we mentioned that only 3 tons out of 16 offered at the ticketing had been sold. Since then it appears that Major Bullen, the responsible general manager, has had to bear the blame for this fiasco, and that he has been dismissed. The board has since asked the advice of Mr. John Daniel, who was recently appointed manager at Poldice and was formerly with the Ropp Tin company, and Mr. W. W. Richardson, who is known to our readers for his rotary sluice-drum. The chairman says that these engineers have revived in his breast the hope and confidence which had such a bad set-back when the ticketing results were published. We are not, however, told that they made reports based solely on the results of their own observations. It is clear that after the ticketing failure and the disappearance of the £45,000 per year profit, it is necessary to make an entirely new and independent examination. It is no use for these engineers to report that they are told this, that, or the other, and that they deduce certain conclusions therefrom. They must test the ground carefully for themselves and give their own personal opinions. No one doubts that the Calloose company's lodes and alluvials are tin-bearing; the question is whether they can be worked profitably.

THE mineral resources of the British Empire occupied the attention of members of the Institution of Mining and Metallurgy at both the annual dinner, held on April 9, and the annual meeting, held on April 15. On the former occasion Sir Richard Redmayne, recently elected chairman of the governors of the Imperial Mineral Resources Bureau, had something to say of the progress of this Government Department, while Mr. Frank Merricks, the new president of the Institution, took as the theme for his address the mineral production of the Empire. Both these engineers played an important part in the work of finding supplies of ore and metal for the Ministry of Munitions during the war, and therefore have a broad knowledge of the Empire's resources and needs. Since the annual meeting, Mr. Hugh F. Marriott has joined the governing body of the Bureau, and he has already taken in hand the important work of collecting information as to the cost of producing gold. With regard to the awaking of England to the necessity of looking ahead in the matter of supplies of mineral products, it is to be observed that foreign countries and the United States are watching this new policy keenly. In America there is considerable anxiety as to England's policy in connection with oil. As the United States resources of oil are given a life of only 25 years by the leading geologists, the position there is undoubtedly serious, and we may expect strenuous competition between the two countries in this particular line.

Metal Quotations.

From time to time inquiries are received by us asking for information as to the methods of buying and selling metals, ores, and minerals on the London Market, and also for advice as to the causes of rises and falls in metal quotations. To put it frankly, we do not altogether relish these inquiries. It is tempting to plead ignorance, or alternatively, as the lawyers say, to allege a fear of saying too much. The fact is, the metal business is a very close corporation, for while there is active and even virulent rivalry within its bounds, yet the barrier between producer and consumer is jealously guarded. New producers are usually regarded as mortal enemies of those in control, and they have to tread either very gingerly or very forcibly, according to the extent of their metal supplies and cash resources. It is always necessary at first to place the business through an old-established firm of brokers or merchants. There are plenty of firms ready to undertake such agencies who can be relied on to do a square deal; but it is always to be remembered that their own interests come first, and that they are not merely colourless intermediaries. Their chief service rendered is to provide a way through the ring of opposition or to forcibly disarm that opposition. It does not do for the journalist to say too much, or to make inquiries into details among members of the Metal Exchange. The least he will suffer by so doing will be to be called an industrious scribbler; the worst we hardly like to specify. The consequence is that the Magazine, in common with other newspapers, keeps its metal reports to official daily quotations and guardedly expressed statements of possible explanations of the variations of prices. We adopt the fiction of endowing the metals with a life of their own, enabling them to go up or down, and we thus avoid the necessity of saying what individual or firm forced the price up or kicked the price down. Journalism in the metal market is far from a desirable occupation. For all we know, even the foregoing expression of disinclination to be mixed up in the turmoil will make for us a mortal enemy in some unexpected place.

There are, however, one or two points in connection with the official metal quotations that may be explained here. A point that gives rise to confusion in the mind of the novice is the combination of two prices in the quotation, the trouble being that with different metals this range denotes different things. In the case of standard copper and tin, the two prices represent buyers and sellers; whereas in electrolytic and best selected copper, lead, and zinc, the first price represents cash and the second three months. A second point not always clear to the new seller is that the quotations on the Metal Exchange are based on a comparatively small turnover, and that the sale of a considerable part of the world's production follows the price and does not influence it. Long contracts for the sale of the products of the mine and smelter call for payments at the market price, and as a rule such sales do not enter into the cognizance of the fixers of the official price. The position is also complicated by the fact that sales and purchases are often made speculatively without immediate means of delivery or intention of consuming, and consequently prices may be governed by many other considerations than the legitimate supply and demand as between producer and consumer. Under these conditions the reasons for the ups and downs of metal quotations are usually obscure. Those in the know don't tell, and those who can make a shrewd guess dare not say anything in public, let alone write about the matter for the papers. Consequently the metal or mineral producer has usually to depend on purely general considerations for his estimation of the future course of the market.

As regards the figures appearing in the quotations, it is well for the beginner to remember that the word "standard" does not refer to the metal, but denotes a standard for the price of the output of the various mines. Before a mine or smelter can dispose of its output through the Metal Exchange, it must register a brand and provide an average analysis. In copper, electrolytically-refined and fire-refined brands ready for consumption are classified as electrolytic and best selected, these having to contain at least 99% copper and range up to 99·8% according to class, while other brands ranging from 96% upwards are sold under the heading of "standard," and their individual prices will depend on the analyses. In many cases it pays the buyer or intermediary to refine standard copper and sell it as electrolytic or best selected. There are some coppers, notably from South America, which are not of high enough quality to come within the standard; these are sold by private contract independently of the Exchange and presumably make their entry subsequently in refined form. In tin, the "standard" was introduced in 1911 for the object of making lode-tin available as good delivery on the Metal Exchange instead of only high-class alluvial tin from the Straits and Australia. Standard now refers to any tin over $99\frac{3}{4}$% pure. As a matter of fact the introduction of the "standard" for tin had little effect on the method of sales; its object was solely to stop wild fluctuations in price arising from the scarcity of supplies good on the Exchange. As we said at the beginning of this article, our treatment of the subject is quite elementary; our reason for writing it is that a great many men new to the business or returning to mining after absence at the war have made inquiries for the information.

The Attacks on Mr. H. L. Sulman.

As our readers are aware, Mr. H. L. Sulman has been attacked recently in a section of the American technical press for a supposed participation in an alleged detrimental policy of the Minerals Separation North American Corporation, and for unprofessional methods of dealing with the information he possesses relative to flotation. On another page in this issue he replies to these criticisms, and as far as he is concerned we agree that he is right in his desire to make this communication his last word on the subject. It is desirable, however, to add a few editorial words in an attempt to help to clear the atmosphere and remove misapprehensions.

It appears to be the impression in America that Mr. Sulman is a large shareholder in the English and American companies owning the froth-flotation patents, and that in this way he has a considerable say in the management of the business of the companies. This supposition is quite wrong. In the early days of flotation he, with his partner, Mr. Hugh K. Picard, was commissioned by Mr. John Ballot and others to investigate the subject, in his capacity of consulting chemist and metallurgist. As is usual in this country under these conditions, his employers would have the right to benefit from any suggestions and improvements made by him. The celebrated patent for a fraction of one per cent of oil constitutes the consummation of Messrs. Sulman & Picard's work on this subject, and, under the circumstances of discovery, the name of Mr. Ballot, who in fact took an active part in the experimental work, was naturally associated with the patent. But Mr. Sulman never received a large pecuniary reward arising out of the commercial results of the application of the patent. Instead, he has received an income for professional services continually rendered, together with a limited share-holding in the parent company. In some ways his case resembles that of Dr. Cottrell, of fume-precipitation fame, who surrendered his patent rights to the United States Government, preferring to continue scientific research rather than be worried by business and legal questions. Thus it happens that Mr. Sulman has only a very small share-holding in the companies owning the froth-flotation patents, and that he has absolutely no voice in the control of the companies' policy, and takes no part in their business management. He, however, is a consistent and loyal supporter of his employers, being called to be so by the usual standard of professional ethics. Hence his words of acknowledgment to Mr. Ballot at the conclusion of his paper read before the Institution of Mining and Metallurgy last autumn. His policy of silence as to new developments is due also to the same consideration, for it is not the proper thing for a professional consultant to talk in public of the business of his employer.

The other grievance that the American press has been airing relates to the method of presentation of the paper already referred to. It is alleged that its publication was unwarrantably delayed and that Mr. Sulman did not give credit to other workers in the same field of research. In a previous issue we have already absolved Mr. Sulman from any reproach on the latter score, mentioning that the paper was not intended as a history of the subject, but that it consisted mainly of an exposition of his own views. With regard to delay in publication, it is probable that this allegation rose from a misconstruction of a remark made in these pages, and quoted by Sir Thomas Kirke Rose, to the effect that Mr. Sulman had written a book on the subject a dozen or more years ago, though it had not been published owing to the litigation position. The object of this remark was to controvert the possible comment that Mr. Sulman, by being rather late in the day in coming into print, had been thereby anticipated by many other writers. As a matter of fact, however, though the book written earlier contained the result of much valuable research, the later paper presented the information from a different point of view, being based on a more recent theory. Thus the second objection falls to the ground. Here it may be interpolated that editors have a natural prejudice against secrecy in the arts and sciences, for a man who is not free to talk or write does not help to fill the pages of the newspaper or magazine. Nevertheless, editors should be able to appreciate the point of view of the other fellow.

Before leaving the subject it is necessary to revert once more to the criticisms aimed really at Minerals Separation and the American Corporation. It is said that, first, the companies exact the full pound of flesh permitted by law, and, second, that they do not keep their licensees fully posted with regard to new developments. These allegations, coming from quarters where it is desired to weaken Minerals Separation and the American Corporation in public opinion and also in legal circles, must be taken with caution. It is hardly any secret, of course, that hostile parties are treated by Minerals Separation and the American Corporation with the utmost rigour of the law, but on the other hand our experience is that reasonable people are met in a reasonable way. As regards the circulation of information relating to new developments, the matter depends largely on the personal alertness of the user and his desire to keep in touch with the service departments of the companies. No prospective user of the froth-flotation process need be scared out of his intention to do business with Minerals Separation by the *ex parte* statements he sees in the American press.

Mining Investments and Speculations.

The art of judiciously buying and selling shares in mining companies does not come within the scope of this Magazine. Our pages are devoted to the technical side of mining operations, and we leave to other papers appearing at shorter intervals the duty of advising investors as to the placing of their money. Every now and then, however, occasion arises for the Magazine to draw attention to this side of the mining business. Such an opportunity is now presented by the publication of a book entitled: "Mines and the Speculative Investor; a Guide to the Mining Markets," written by Mr. J. A. L. Gallard.* The author hardly requires any introduction to our readers. For fifteen years, until December last, he was the mining editor of *The Financial Times*, and during all that time he had unfettered control of his department. The subject matter of this book appeared as a series of articles in our contemporary, and they summarized the advice which he had been giving day by day to the readers of that paper, either in its pages or by correspondence. As regards the title, it may be questioned whether it fully represents the author's view of mining investment or the range of subjects treated. Such criticism, however, is neither here nor there, for an author is not always free to choose his title, owing to a desire to prevent confusion with other books or writings on the same subject.

It is impossible within the small space here available to give anything like a comprehensive outline of the features of the book. The author begins by reminding investors that a mining prospect or even a proved ore deposit is an asset that can only be valued with difficulty, and he then proceeds to explain in simple terms the main engineering and geological con-

*Published by Walter R. Skinner, and for sale at the Technical Bookshop of *The Mining Magazine*; price 7s. 6d. net siderations that make it possible to estimate the value from time to time. He discusses the various methods of mining and metallurgical treatment, the influence of ore reserves on the policy of the operating company, and the varying degrees of reliability in the estimation of reserves according to the nature of the ore. From these he passes on to an examination of the methods of presenting engineers' reports on the properties, of issuing directors' reports, and of dealing with shareholders at annual meetings. In final paragraphs in this section of the book, he points out that there are two classes of mines, the first producing or having a definite chance of producing metals, and the second "market mines," which are used solely for the purpose of working-off shares on an unsuspecting public. He also draws attention to the fact that the market quotations of even the most regular and old-established producers and dividend-payers are often much higher than is warranted.

In the next section of the book, the author deals with the formation and flotation of companies, the methods of introducing shares to the public by prospectus or otherwise, the management of finance and exploration companies, and the policies connected with amalgamation and reconstruction. In the third section, he compares mines with other industrial enterprises, and gives his views as to the rate of return on one's money that is desirable. He devotes space to the argument that publicity is always desirable, and to a statement of the case as between directors and shareholders in this connection.

The above is merely a bald outline of the subjects covered by the author. His method of presenting the various matters is breezy and caustic. He does not spare the careless or ignorant shareholder, the callous or tricky director, or the inflator of values on the Stock Exchange. The irresponsible optimist, either buyer or seller of shares, will consider him far too gloomy, but an unbiassed adviser on these subjects could not take any other attitude than one of perfect frankness as to the many pitfalls in connection with mining investment and speculation.

The placing of money in mining shares is, under all circumstances, a matter that requires great judgment. Whether this is called "investment" or "speculation" matters little; the correct word depends on the definitions preferred by each individual. We do not here refer, of course, to that section of speculation which consists simply of in-and-out transactions on the Stock Exchange; it is only buying to hold that concerns us. For ourselves we call the purchase of shares in a company formed to develop an unproved property "a speculation," and the purchase of shares in a company owning a producing mine an "investment attended with some risk." It is clear that the public is attracted to mining shares by the chances of big and unexpected developments, which will cause substantial market appreciations of the shares, and sometimes in addition yield handsome dividends. The inexperienced investor is usually attracted by the promise of dividends at a high rate. On the other hand the graduates in speculation look rather to an appreciation in share values, knowing that in nine cases out of ten a hopeful development will bring in buyers from the less experienced section and thus raise the quotation, whether the mine is producing or not. A maxim that often leads the inexperienced man astray is the advice to buy when quotations are falling or when everybody else is selling. This is a maxim that has to be applied with care, and with a thorough knowledge of the inside conditions connected with each particular share. We have known the unsuspecting ones buy shares in Transvaal gold mines nearing their end, bravely quoting Jay Gould's motto. What this financier really meant, though he did not say it, was that some one with inside knowledge can make a profit by circulating a false report and stampeding the market. This is, however, not much different from our old friend the bear and his tactics. It is clear that, in mining, this maxim is an extremely dangerous one to the outsider.

It hardly becomes an organ of the mining industry to say too much of the disadvantages of mining shares as either investments or speculations. Nevertheless, it is no use avoiding the fact that nearly all companies are over-capitalized at the start, and that subsequently the buying price on the Stock Exchange is higher than is warranted by strict commercial considerations. Each individual gets his own experience, and the clever ones among them reap the benefit of it. In every case the speculator, to be successful, must, first, know the personality of the control and management, and, second, get out at a profit while things are still booming. This holds good whether the property is merely a prospect or whether it is an old-established sound dividend-payer. A perusal of Mr. Gallard's book will give the investor and speculator a correct perspective of things as they exist in the mining share-market, and nothing that we can say will improve on his presentment of the subject.

REVIEW OF MINING

Introduction.—In mining circles oil holds chief attention at present. The commercial considerations are largely interwoven with international politics. A severance of the Shell and Royal Dutch groups has been spoken of as a means for enabling the British Government to take an interest in the Shell, but it appears more likely that the Government will work through the Anglo-Persian when taking participations with the Shell-Royal Dutch, at any rate in Mesopotamia. In metal-mining circles the slump in prices has continued, and silver has fallen below coinage value again. On the Rand a crisis has at last arrived with many of the low-graders, and stoppages have already commenced.

Transvaal.—The reports of the various companies for the year 1919 are now coming in. As we have said on many occasions, it is a pity that they come in crowds, for close examination of each individual report is thereby made difficult. In another part of this issue we give abstracts of the reports of the Barnato and Consolidated Mines Selection groups. Of the Barnato group, the Government Areas continues to be by far the most interesting property; the development and yield are highly satisfactory. As regards the Consolidated Mines Selection group, the mining results have not been so good lately; Brakpan has had difficult roof conditions in the south section, and Springs shows a drop of 4s. per ton in yield and an increase of cost of 4s. 3d

In view of the vanishing profits at low-grade mines in spite of the gold premium, the Albu group are considering the advisability of adopting selective mining, only working the best portions and substantially reducing the staff. Arrangements have already been made to this effect at Aurora West. At New Goch, Roodepoort United, and West Rand Consolidated the position is much the same, and a reduction of tonnage may be expected shortly, though it is more likely that Roodepoort United will be closed down. The policy of selective mining has also been studied at the mines of the Gold Fields group, but the engineers are not in favour. With regard to Simmer Deep, they show that only a fifth of the ore reserve is over 6 dwt. per ton and that the reduction of stoping width would ruinously increase the cost per ton. It has been decided therefore to close Simmer Deep and Jupiter.

The Princess Estate gold mine is to be closed down owing to decreased yield and increased costs; also on account of the poor condition of the workings and the backwardness of development. This mine has never been a great one, and the total dividends have amounted to only 14s. 6d. per £1 share, paid from 1897 to 1911.

The City & Suburban mine and plant is to be sold to City Deep for 45,000 shares in the latter company. The yearly report, quoted elsewhere in this issue, showed a loss in working during 1919 in spite of the gold premium. This was largely due to shaft troubles, and further falls have occurred since the turn of the year, as already recorded in these columns.

The Kleinfontein report for 1919 shows that operations would have resulted in a loss if it had not been for the gold premium. Since the issue of the report, it has been announced that the company has suspended development and mining in the Apex section owing to the patchy nature of the ore disclosed. This is a most disappointing event, but it was evidently foreshadowed by the leasing of the Apex plant to the Modderfontein East company.

The Modderfontein East company commenced milling on April 23, using the Apex mill of the Kleinfontein company for this purpose. Reports of tonnage and extraction will commence at the end of May.

The Nigel company, whose mine was shut down in 1918, awaiting more favourable times, has made an arrangement with the Sub-Nigel, whereby the latter undertakes to continue its 16th level into Nigel ground. The length of the drive will be 3,500 ft. The work should yield useful evidence as to the gold content in this part of the Nigel deep-level ground.

The Rhodesia Exploration Co. has issued a report by Mr. G. A. Denny on the Maraisdrift and Klippoortje properties in the Far East Rand, in the development of which the company is interested. In his speech at the meeting of shareholders, Mr. F. H. Hamilton went into this matter fully, and incidentally referred to the fact that those in control of the operations had only been looking for one reef, that is, the continuation in a south-west direction of the reef worked at Nigel. Mr. Bleloch's theory of the possibility of finding two payable reefs in the Main Reef Series has never been accepted by any other geologist on the Rand. This theory has now received its quietus among both scientific and business men.

Cape Province.—The Namaqua Copper Company has not yet been able to resume smelting, owing to high cost of coke and freight and inadequate transport facilities. During the past year attention has been devoted to development, and the ore reserve has been increased by 12,000 tons, containing 1,190 tons of metal. The mining, concentration, and smelting plant is kept in excellent order, and is ready to start whenever conditions warrant.

Diamonds.—The diamond production of the Union of South Africa in 1919 was 2,588,017 carats, an increase of only 50,657 carats, but the value was returned at no less than £11,734,495 as compared with £7,114,867. For the first time since 1913 the yield of alluvial diamonds exceeded 200,000 carats; the average value was £13. 1s. 6d. per carat, as compared with £6. 14s. 6d. in 1918.

Rhodesia.—The dispute between the various directors of the boards of the Globe & Phœnix Gold Mining and Phœnix Mining & Finance companies has been settled by agreement. The chairman, Earl Russell, and his supporters are to retire. The terms are not disclosed in detail, and much of the information issued by the two companies in connection with this dispute will not be understood by shareholders or the public.

West Africa.—The Akim Diamond Fields, Ltd., has been formed as a subsidiary of the Goldfields of Eastern Akim, Ltd., for the purpose of acquiring four leases in the Abomosu district, Gold Coast Colony, where diamonds were found last year by Mr. A. E. Kitson, Director of the Geological Survey. We published Mr. Kitson's account of the discovery in the Magazine for September last. The capital of the new company is £300,000, in 300,000 shares of £1 each, of which 115,000 shares are issued fully paid as purchase consideration, and 70,000 have been offered for subscription, the remaining shares being held in reserve. Mr. Kitson's account showed that the diamonds were small and sparsely distributed over a wide area. The present knowledge of their occurrence hardly warrants the high valuation put on the property by the promoters of the company.

Nigeria.—The Premier Hydraulic Tin Mines of Nigeria has been formed this month to acquire properties examined by Mr. J. Jarvis Garrard. The flotation marks the entry of the Central Mining & Investment Corporation and the National Mining Corporation into Nigerian mining.

Australasia.—In this issue is published a paper by Messrs. C. M. Harris and L. R. Benjamin on the Hampton Plains developments. This contains information relating to the workings at Celebration, White Hope, and other properties. The index maps of the claims so far registered will prove of use for purposes of future reference. Those who read the article will wonder what is the justification for the high capitalization of most of the companies, the shares of which are on the market. It is, of course, the old story of companies always being over-capitalized in boom-times.

News from Broken Hill shows that repeated efforts are being made to arrange terms between mine-owners and men, but so far without result, and the mines are still idle. As regards labour conditions at Kalgoorlie, the scarcity of miners has become still worse, owing to the rival attractions of the Hampton Plains district.

The Ivanhoe made a divisible profit of £71,409 for 1919, but of this amount £41,220 came from the gold premium. During the current year the cost per ton is estimated at 31s. 6d., while the average assay-value of the reserves at par is 33s. 9d., of which 29s. 7d. is recoverable. Thus it is evident that only the gold premium will maintain the profit, unless, of course, recourse is had to selective mining. The ore reserve is estimated at 972,387 tons averaging 33s. 9d., as compared with 1,000,209 tons averaging 34s. 2d. per ton a year ago. No ore has been discovered below the 2,420 ft. level during the last six years. At the present time the East Branch Lode is providing most of the new ore.

The report of the Sons of Gwalia for 1919 shows that, in spite of shortness of labour, considerable development was done with gratifying results. In particular the 25th level has provided much milling ore. The reserve has been well maintained and stands at over three years' supply for the mill. The ore treated during the year was 147,652 tons and the yield 48,625 oz. The revenue from the sale of gold was £239,486, of which £32,693 came from gold premium. The profit, after payment of taxes and allowance for depreciation, was £28,328, out of which £16,250 was distributed as dividend, being at the rate of 5%. It will be seen from the above figures that the company would not have made a profit but for the gold premium.

During 1919 the Waihi company treated 192,613 tons of ore for a yield of gold and silver worth £380,042. The balance of profit was £187,916, out of which £47,319 has been placed to income-tax account, £15,302 has been written off for depreciation, £50,000 has been placed to a dividend-equalization account, and £100,000 has been paid as dividend, being at the rate of 20%. The reserve has been depleted during the year by 159,932 tons, owing to the cessation of development in depth during the period of waiting for new pumps. It is expected that this plant will be despatched from England in June. It is proposed to reduce the shares from £1 to 10s. each by the return of capital. The company holds a large reserve in gilt-edged securities, which has been recently increased by the receipt of bonds worth £212,500 from the New Zealand Government in payment for the Hora-Hora hydro-electric plant. The directors say that owing to the present low prices of gilt-edged securities they do not intend to proceed with this reduction of capital immediately.

The Laloki Copper Mines Co., operating in Papua, reports that the proved ore at Laloki is estimated at 300,000 tons averaging 4·8% copper and $2\frac{1}{2}$ dwt. per ton gold, and at Dubuna 50,000 tons averaging 4·8% copper and 3 dwt. gold. The Laloki workings are down to 140 ft. and those at Dubuna to 200 ft. The ore runs 40% in both iron and sulphur and is low in silica. There is every expectation that the ore-bodies continue in depth. The mines are about 15 miles from Bootless Inlet and a connecting railway is under construction. Smelting works are to be erected at Bootless Inlet. The Rouna Falls will provide hydro-electric power. Messrs. G. C. Klug and Erle Huntley have reported on the mining and metallurgical problems. Additional capital is now being raised.

The Australian Federal Government has placed its oil-boring operations in Papua in the hands of the Anglo-Persian Oil Company. The Government is also arranging with the Anglo-Persian for the establishment of centres for distributing oil-fuel at the various Australian ports.

Particulars are now available of the iron and steel works to be erected by the Queensland Government at Bowen, the seaport 725 miles north of Brisbane. The works are to cost £3,000,000, and the money is to be raised by a special loan. The plant will consist of one blast-furnace with a capacity of 350 tons of pig iron per day, a slag-cement plant, a battery of by-product coke-ovens, four open-hearth steel furnaces each of 60 tons daily capacity, one blooming-mill, and one combination rail and structural mill.

India.—The Indian gold mines have made a new arrangement with the Government of India for the disposal of their output. During the war the gold was sold to the Bank of England at par and deposited at the Bombay Mint. A year ago this procedure was modified, half being sold to the Bank at par and half to the Government of India at an improved price. Under the arrangement now coming into force, the Indian Government has the option to purchase the whole or any portion of the output at the London market price calculated at the current rate of exchange. Such portion of the output not sold to the Government may be sold by the producers in any way they choose. The Indian Government is beginning by taking 75% of the output, payment for which will be made as to two-thirds in India at the ruling rate of exchange and one-third in sterling in London. This arrangement is more satisfactory to the mines than the old one, but there is still a serious disadvantage arising from the fact that Indian exchange is against them. The arrangement lasts for one year certain, and thereafter from month to month.

Malaya.—At the Pahang Consolidated's tin mines, Willink's lode is the biggest producer, and as reported last July the 900 ft. level is responding well to development. It is now announced that Nicholson's lode is also doing well. After being rather patchy on the 700 ft. level, it is proving of higher grade on the 800 ft. level. The latest report shows that the first 160 ft. of driving is in ore averaging 6% tin over 48 inches.

The Gopeng Consolidated continues to be worried with the question of tailings disposal, which greatly adds to the cost. In all probability the engineers have considered the advisability of treating the ground in some other way than by hydraulicking. The yardage and output of tin concentrate, though still large, show a gradual decrease. During the past year this shrinkage was due partly to shortage of water and partly to the fact that lower levels were worked. These two items also suggest a possible variation in the method of treatment. In spite of the drawbacks mentioned, the property, being extensive, should be a dependable producer for many years.

There has been a boom in Melbourne in connection with the shares of the Badak syndicate, which owns alluvial tin ground at Jeneri in the State of Kedah, Federated Malay States. Mr. Orton, the manager, reported high results of bores over 100 acres, the values varying from 4 to 34 lb. per cubic yard. Mr. W. Wilson, a boring expert, was sent to investigate, and his cables so far have been of a confirmatory nature. Well-informed people, however, prefer to wait for the results of closer boring and the testing of a larger area, and they point to the serious discrepancy between bore assays and dredging results at other properties in this part of the Eastern tinfield, notably at Ronpibon Extended and Deebook.

Cornwall.—It will be remembered that Tehidy Mansion, the ancestral home of the Basset family, was burnt shortly after it had been acquired for a war memorial as a home for tuberculosis patients. It is now announced that the house is to be demolished, and an entirely new house built which will serve the purpose better.

Killifreth mine made a first appearance at the Redruth Tin Ticketings on May 3. The amount sold was 12 tons and the price obtained was £200. 7s. 6d. per ton, as compared with the average of £189. 5s. 9d. recorded on that occasion.

Derbyshire.—Official information relating to the Derbyshire borings for oil continues to indicate that operations are stopped partly by want of pumping plant and partly by the dispute as to the ownership of the oil. The outsider naturally wonders whether these are excuses or reasons. The Hardstoft bore is reported to be yielding 9 to 10 barrels per day. Baling by double shift has given a yield of 35 barrels per day. It is not stated what the chances are of pumping being undertaken.

Canada.—Announcement is made of a big consolidation of iron mines, steel works, shipbuilding yards, and steamship lines. This is being arranged between Canadian owners and British capitalists and steel and shipping people, among the latter names being Beardmore and Furness. The steel companies involved are the Dominion Coal and Steel companies and the Nova Scotia Steel and Coal Co. These own coalfields in Nova Scotia and iron ore deposits in Newfoundland. The formation of this merger will result in an important imperial tie.

United States.—The *Mining and Scientific Press* states that Minerals Separation North American Corporation has acquired the Scott patents for the use of gaseous hydrocarbons as frothing agents in the flotation process. A note of this process was given in the Magazine for October last. The patentee is a lawyer who used to act against Minerals Separation in the American lawsuits. No statement has been made as to the value of this process or the reason for the purchase of the patents.

Mexico.—News from Mexico indicates a revival of the power of the anti-Carranzists and another revolution is in full swing. It is reported that Obregon has taken possession of Mexico City and that Carranza is a prisoner. Obregon's party is also in control in the El Oro gold-mining district.

Trinidad.—The Apex (Trinidad) Oilfields Ltd. is issuing new capital for the purpose of development and drilling. The company was formed recently by the Anglo-French Exploration Co., in association with the British Borneo Petroleum Syndicate. The property is in a compact block adjoining that of the Trinidad Leaseholds, which contains the most important oilfield on the island. Messrs. A. Beeby Thompson & Co. and Dr. J. A. L. Henderson have reported favourably on the prospects. A rotary drill capable of boring to 3,500 ft. has been delivered, and the first test well has been started. It is believed that oil will be struck at depths from 700 ft. to 1,500 ft.

Colombia.—The half-yearly report of the Frontino & Bolivia Gold Mining Co. to December last shows that 15,640 tons of ore yielded 13,098 oz. of gold. The ore reserves have been well maintained, standing at 56,100 tons averaging 17 dwt. There is also 10,600 tons averaging 11·2 dwt., but it is uncertain how much of this can be stoped profitably. Messrs. Pellew-Harvey & Co., the consulting engineers, are arranging for a geological examination of the property.

Brazil.—The Ilha diamond-gold property is being actively developed by the Cascalho Syndicate, a company formed a few years ago in London. The property adjoins the Jequitinhonha river and its tributary the Macuhubas, in the Diamantina district, Minas Geraes. A test of 1,250 cu. yd. made by Mr. C. M. Spangler yielded 152 carats of diamonds and 203 oz. of gold. A drag-line excavator and a washing-plant with a capacity of 500 cu. yd. per 10-hour day has been delivered and may be expected to start work shortly.

Russia.—At the statutory meeting of the Russo-Asiatic Consolidated it was announced that the company is interesting itself in ore deposits outside Russia and Siberia. It is understood that a mine in the Pyrenees is being examined.

The oil wells at Baku are now in the hands of the Bolshevists and are being worked at the direction of the Soviet Government.

Spitsbergen.—This year's expedition of the Scottish Spitsbergen Syndicate will be led by Mr. John Mathieson, lately of the Ordnance Survey, who accompanied the two former expeditions in the capacity of surveyor. The geologists are Mr. G. W. Tyrrell, of Glasgow University, Dr. Robert Campbell, of Edinburgh University, and Mr. J. M. Wordie, of Cambridge. Three vessels carrying the party left Granton early this month.

THE HAMPTON PLAINS DISCOVERIES, WEST AUSTRALIA.

By C. M. HARRIS, M.Inst.M.M., and L. R. BENJAMIN.

THE discoveries of gold-bearing lodes on what are now known as the Celebration Lease and the Mutooroo Lease, on Block 50 of the Hampton Properties company, and that on the White Hope Lease, on Block 48 of the Hampton Areas company, add another romance to prospecting.

Over fifty years ago, and long before gold was found in West Australia, Explorer Hunt "blazed" a currajong tree, inscribing his initials on it, right over the outcrop of the White Hope lode. There is now a trench under the shadow of this tree, in which a lode 10 ft. in width is exposed, containing payable ore. Some quarter of a mile S.S.W. along the strike of the lode is a dry watercourse known as McPherson's Gully, discovered and worked for alluvial gold eighteen months before Coolgardie was found.

For several years the Hampton Plains company worked at a loss a number of lodes in which the gold is found in the quartz seams in a wide porphyry lode; but the managers never thought of looking for the sheared zone in the adjacent altered gabbro and dolerite. The writers, on their inspection of the field for this article, discovered a schist lode containing fair gold content on a lease reserved by the company on a track that had been constantly travelled over.

On the Mutooroo Lease, dry-blowers had been working surface alluvial for years, and even mining rich ironstone seams, which returned them up to £20 per ton, but leaving the £2 ore as not worth the cost of carting to Kalgoorlie.

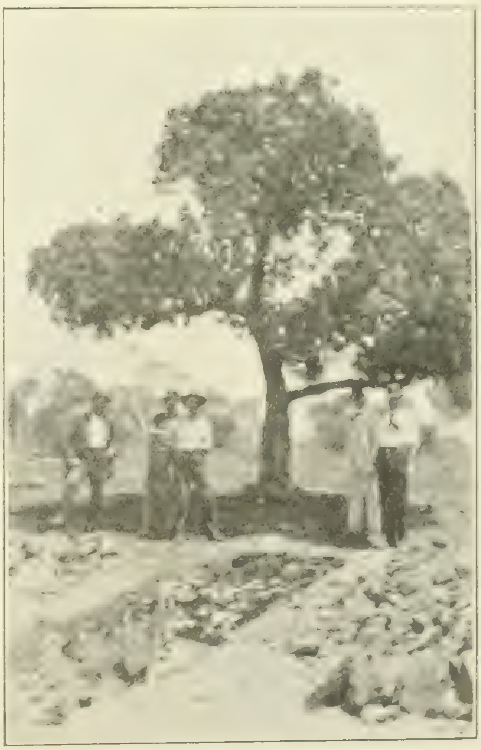
On the Celebration Lease the railway line, on which firewood was sent to the Boulder mines, ran parallel to the lode, and the carters camped almost on the outcrop for a considerable time.

The discovery by Hansen, an up-to-date prospector using loaming methods, has already been described in the Magazine, but it is well to accentuate the fact, to show that since this discovery was made, and prospecting carried out on systematic and scientific lines along shear-zones, numerous other finds have been made, some of which will prove to be payable mines when further developed.

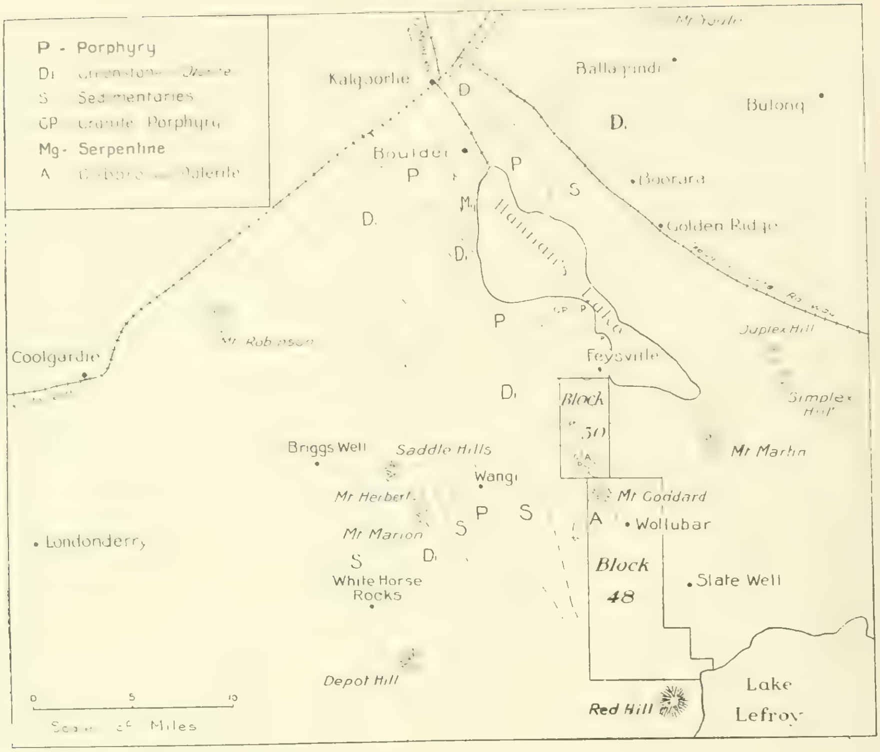
From Broad Arrow, on a line bearing about 25° east of south, through Smithfield, the north end of Kalgoorlie, Boulder, Hit or Miss, Blocks 50 and 48, Starlight, Red Hill, and on to Widgiemooltha, a distance of over 80 miles, the country is being given a thorough trial by prospectors. When the Government wakes up from its sleep, and realizes that scientific prospecting pays, it will increase the number of its economic geologists, and more rapidly map out the areas on which such work can be concentrated.

By referring to the sketch map (p. 269) showing a few of the characteristic geological details of Block 50, the following explanation may be better understood in confirmation of Mr. C. S. Honman's opinion that the discoveries on this belt are almost a replica of those on the Boulder area.

Bounded on the east and on the west by



CURRAJONG TREE ON THE WHITE HOPE OUTCROP
This tree was blazed by Hunt fifty years ago.



Map of the District to the South of Kalgoorlie.

ancient sediments, the rocks of Blocks 50 and 48 consist of a complex of igneous rocks across the centre of Block 50. The lodes of Block 50 bear a close resemblance to those of the Kalgoorlie-Boulder belt, both in appearance and in their associations.

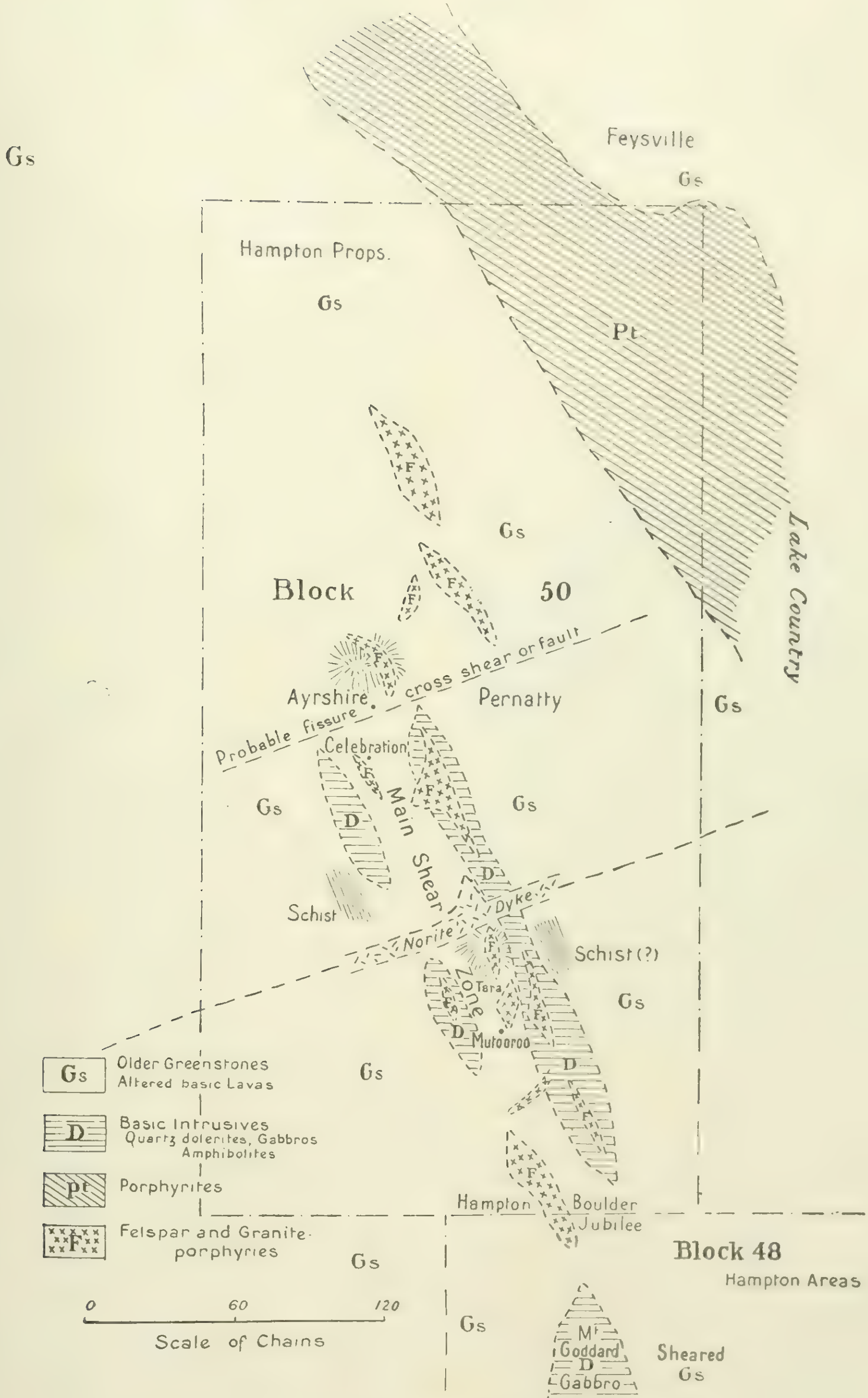
The rocks of the new field are closely related to those of the above series, and are, in our opinion, the southern extension thereof. The field relationships are, as far as ascertainable at the time of writing, practically identical with those existing between the members of the Kalgoorlie-Boulder portion of the belt. There is the same widespread distribution of the ancient basic lava flow (greenstone); the subsequent intrusion thereof by basic magmas, now represented as amphibolites, gabbros, and dolerites, and the later intrusion of the whole of this basic series by the less basic porphyrites, and the acidic felspar and quartz porphyries.

Although the relationships of the rocks one to another are similar to those pertaining to the Kalgoorlie series, there is one important difference.

The basic intrusives and ore-bearing rocks of the Golden Mile are bounded on the east and cut into on the south by the later porphyrite. It is fairly generally held that this intrusion was largely responsible for the shearing and subsequent alteration of the quartz-dolerite in which the famous Boulder group of mines is situated, and, furthermore, that one of the chief factors determining the mineralization of these shear-zones was the intrusion thereof by apophyses or offshoots of quartz and felspar porphyry from the main porphyrite magma.

A reference to the sketch map will show that the nearest outcrop of the main porphyrite intrusion is about $2\frac{1}{2}$ miles east of the Celebration-Mutooroo shear-zone. At the Golden Mile the porphyrite is to the west of the shear-zones, and at no point distant more than a mile from any important workings.

As a result of the greater distance of the Block 50 ore-channels from the porphyrite, it might be argued that the shearing would be much less intense, and hence the chances of impregnation with ore minerals considerably reduced. On the other hand there appears to be a very much greater development of the porphyries in the neighbourhood of the Block 50 mines than at Boulder. These in themselves might account for the considerable local shearing which undoubtedly exists, as well as



Geological Sketch Map of Block 50, Hampton Plains.

being largely responsible for the alteration of the sheared rocks and the impregnation thereof with ore minerals.

The sheared rocks of what has been termed the "main shear-zone" are so greatly altered that it is impossible at present to decide whether they are the products of alteration of the basic intrusive mass which bounds them

RESIDENCE OF MANAGER OF THE CELEBRATION MINE.

on the east, and apparently on the west also, or whether they are derived from the ancient greenstones themselves. As the later intrusive greenstone forming the low eastern ridge has been determined as quartz-dolerite,* and the rock of the western ridge has similar field characteristics, it seems reasonable to suppose that both were formerly continuous, and represented a laccolith which has been sheared along its major axis. Subsequent alteration and impregnation of the sheared zone produced the lodes now being developed, and erosion has accounted for the removal of the softer sheared matter at a greater rate than the massive rock, thereby producing the present topographical features.

An interesting feature, representing what appears to be the last stage of igneous activity, is the occurrence of a fairly broad norite dyke cutting across the strike of the older series almost at right angles. The same dyke has been traced by Honman for at least nine miles, and no doubt extends still further eastward beneath the lake country.

Parallel with the strike of the norite, and traversing the leases adjoining the Ayrshire on the east, and probably on the west also, there appears to be a fairly well-defined line of sheared and fractured rock, traceable more easily on the east owing to the higher ground and the presence of a quartz reef following the apparent line of shear. On the Ayrshire the zone is obscured by the large amount of overburden, but the topography hereabouts indicates its continuation to the west.

The quartz of this cross shear has a decided secondary appearance, and in places carries gold. In our opinion this gold has been derived from the north-west-north shear-zones, and the cross reefs or lodes in this vicinity will prove of little or no economic importance. On the other hand, the disturbance hereabouts will no doubt necessitate a good deal more prospecting being done in order to pick up the northerly extension of the Celebration shear-zone than would otherwise have been the case.

That the latter shear-zone does extend northward there can be but little doubt, and there is no apparent reason why it should not continue to carry similar values, since the intervening disturbed area was no doubt produced after mineralization of the original shear-zones had been affected.

As the norite is probably of the same age, though perhaps representing a fissure which extended to a much greater depth than the one above-mentioned, its effect on the earlier shear-zones and the distribution of gold therein will be of a similar nature.

What has been said of the Block 50 lodes and rocks applies to the adjoining portion of Block 48, though the development of the porphyry, in conjunction with the Mt. Goddard gabbro, is apparently limited to a few patches of no great size.

The middle, or White Hope, portion of Block 48 presents features differing considerably from those of Block 50, and apparently, as far as is known to us, not presented elsewhere in this State. The lodes themselves will probably prove to be of the same lenticular nature as those of the Boulder area, without well-defined walls and of varying length and width, but persisting in their cross section with depth. To a depth of about 200 ft. they

* See *Bulletin* 66, G.S.W.A., C. S. Honman.

will no doubt retain the soft kaolinitic and limonitic nature displayed in the workings down to the 100 ft. level. This oxidized ore, though kaolinitic, contains but a very small amount of "clay substance" and should present little, if any, metallurgical difficulty.

The developments on the various mines are being pushed on so rapidly that, even during the time taken between the writing, transit, and publishing of this article, they will be more or less out of date. But for those readers in other portions of the Empire, some particulars of the size and value of the lodes as opened up at present may be of interest.

The Celebration lode has been developed for a length of 250 ft. at the 100 ft. level, and by means of a number of cross-cuts has been shown to average 20 ft. in width, and assaying $12\frac{1}{2}$ dwt. of gold per ton. The drives north and south are being continued and a new main shaft will be sunk to test the size and value of the lode in the sulphide zone. At the present time the lode consists of quartz veins on the foot and hanging walls, the central portion being altered and kaolinized dolerite, with seams of quartz, ironstone, and jasper, in which the gold occurs in a free state. Over an area not yet quite defined, the country is disturbed by the quartz and norite cross fissures shown in the sketch map. Just as this is being written (March 4), a report has come in that the Celebration lode has been cut to the south of the cross fissure in the Ayrshire mine, carrying ore of good value.

Coming south the lode-channel is covered by a considerable depth of alluvium until the Mutooroo Lease is reached. On this mine the ironstone and quartz seams come up almost to the surface. At a depth of 50 ft., an oxidized lode has been cross-cut, which assays $1\frac{1}{2}$ dwt. per ton over 10 ft., and 4 oz. over the remaining 5 ft. The lode has been exposed in several costeens along the strike, and the company is obtaining a report from a mining engineer at Kalgoorlie with reference to the further development of the property. On the Mutooroo East, which adjoins this lease, a parallel ore-body in the same shear-zone has been found, and considerable attention is being paid to the leases in this vicinity on account of the amount of alluvial gold obtained over a width of a quarter of a mile, the gold probably being due to the denudation of the lodes.

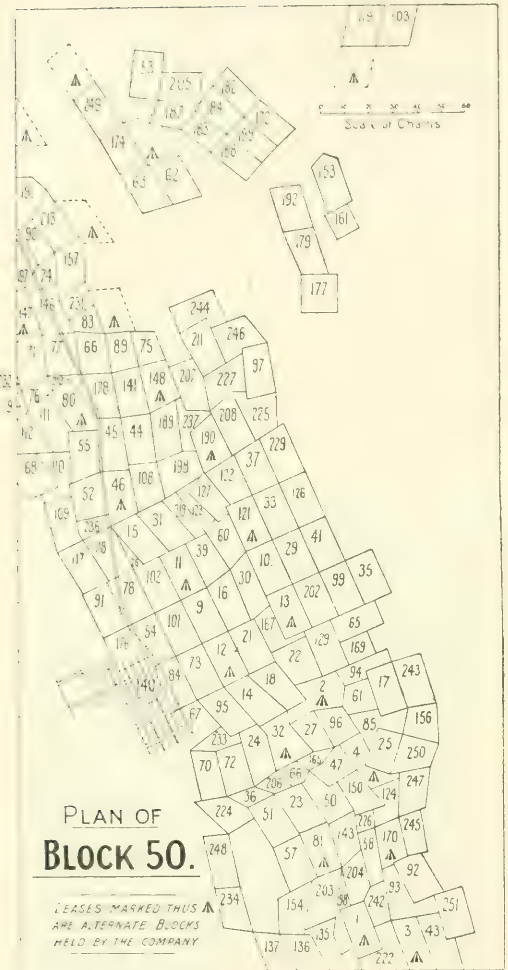
Nothing of any value has been cut so far in the leases south of the Mutooroo to the boundary of Block 50, although, owing to the geological conditions in the shear-zone on the Hampton-Boulder and Jubilee Leases, a body of pay ore may be looked for in the schist adjacent to the quartz-porphyry lodes.

As the belt is followed south-west into Block 48, the greenstone becomes more massive, the eastern ridge of hills having given place to flats with a great depth of alluvium in which prospecting is more difficult.

Leaving Mt. Goddard on the right (west), on the Golden Hope, known as Lennebergs, a quartz-porphyry lode is being worked, which is said to carry gold up to 10 dwt. per ton.

THE CELEBRATION SHAFT

Very little development work, however, has yet been done to show the possibilities of this lode. At several other points this type of lode is being prospected, but nothing of practical interest has been found until the White Hope mine is reached. This is the most spectacular lode on the field. It has been classed as a quartz gabbroamphibolite, sheared and mineralized. The pyrite comes to within a few feet of the surface, which is quite a new feature in West Australian mining. The lode has been proved by costeens on the surface for a length of nearly 1,000 ft., the width varying from 10 ft. to 20 ft. and the assay-



LEASES ON BLOCK 50.

1 Hampton Boulder
2 Reserve Block
3 Reserve Block
4 Reserve Block
9 Hampton Celebration
10 Pernatty Central
11 Ayrshire
12 Celebration Junction
13 Reserve Block
14 Celebration South
15 Princess Royal
16 Celebration East
17 Peace Gift
18 Isobel Maude
21 Hampton Celebration
22 Great Eastern
23 Mutooroo
24 Bullfinch Proprietary
25 Adelaide Hampton
26 Celebration North-West
27 Edna May Golden Point
29 Annamax Extended
30 Pernatty West
31 Lanarkshire
32 Reserve
33 Annamax Extended North
35 Kalgoorlie R.S.A.
36 Lucknow
37 Annamax Extended No. 1
39 Hansel Mandy
41 Boulder R.S.A.
43 Little Wonder
44 Happy Jack
45 Celebration North Extended
46 Reserve
47 Hill End Blocks
48 Celebration Central
50 Mootooroo East
51 Mazda
52 Hampton Doris
53 Merrick Extended
54 Celerity
55 Golden Gate
57 Troender
58 Edna May Consolidated Extended
60 Pernatty North
61 Pioneer's Luck
62 Sunlight
63 Gadfly
65 Roy
66 Roberts' Celebration
67 Celebration South-West
68 Hope G.M.
70 Surveyor
71 Roberts' Celebration
72 Buick
73 Gala
75 Kurrajong
76 Roberts' Celebration
77 Roberts' Celebration
78 Celebration West
80 Reserve
81 Villers Brettonaux
83 Lapis Lazuli West
84 Pax
85 Hampton Court
89 Bunbury Armistice
90 Melba
91 Hurleston G.M.
92 Aurum
93 Phoenix
94 Pernatty South
95 Early Bird
96 Celebration United
97 Kingfisher
98 Celebration Boulder
99 Annamax Consols
101 Ireland Celebration
102 Ayrshire
103 Paris Gift East
108 Celebration Main Lode Block
109 New Commodore G.M.
110 New Commodore G.M.
111 New Commodore G.M.
112 New Commodore G.M.
117 New Commodore G.M.
118 Just-in-time
119 Edna May Murton
121 Reserve
122 Morris
123 Hill Side
124 Mootooroo Consols
126 Annamax Main Reef
127 Annamax North
129 Nidaros
135 Hampton Boulder West
136 Hampton Boulder Central
137 Hampton Boulder Deeps
140 Star of the Sea
141 Bunbury Armistice
143 Mootooroo South
146 Consolidated
147 Reserve
148 Reserve
150 Mootooroo Consols
153 Victory
154 Moquet Farm
156 Dates' South Extended
157 Three Macs
161 Triumph
165 Edna M. Golden Point
166 Mootooroo North
167 Celebration Consols
169 Nidaro's Extended
170 Reserve
172 Last Chance
174 Kyarra G.M.
176 Adelaide Enterprise
177 Kyarra G.M.
178 Armistice
179 Kyarra G.M.
182 Kilrush
183 Melvina Hampton West
184 Melvina Hampton West
187 Hampton View
188 Hampton Proprietary
189 Dawn of Day North
190 Reserve
191 Boundary
192 Kyarra G.M.
198 Three B.'s
199 Melvina Extended
202 Pernatty Consols
203 Bertha May
204 Mootooroo Junction
205 Merrick
206 Mootooroo North
207 Kalgoorlie Hampton No. 6
208 Kalgoorlie Hampton No. 7
212 Celebration Triangle
213 Kalgoorlie Hampton No. 5
214 Golden Hole
219 Lanarkshire
222 Hampton Jubilee
224 Celebrity S. West
225 Hunter Celebration
226 Mootooroo Consols
227 Hunter Celebration No. 1
229 Annamax No. 1 North
231 Consolidated Extended
233 Emerald
234 Hampton King
237 King Pin
242 Hampton East Extended
243 Willard
244 Johore
245 The Brothers
246 Taiping
247 Kia-Ora
248 Hampton Queen
246 Ypres No. 1
250 Adelaide Hampton
251 Quality

LEASES ON BLOCK 48.

1 White Hope
2 Tarcoola
3 North West
4 Hansel Mundy
5 White Hope Central
6 White Hope Imperial
7 Hampton United Syndicate
8 Hampton United Syndicate
9 Celebration South
10 Reserve
11 Celebration South
12 White Hope Consols
13 Celebration South
14 Reserve
15 Reserve
16 White Hope Junction
17 Golden Butterfly
23 Hampton United Syndicate
24 Reserve
25 White Hope North
26 Reserve
27 Golden Butterfly
28 Reserve
18 Golden Hope
29 Reserve
30 Lloyd George
19 Reserve
20 Reserve
21 Reserve
22 Reserve
31 White Hope Extended
32 Red Indian Consols

34 Reserve
35 Reserve
37 Ringneck
38 Hampton Lodes
39 ——
40 Hampton Consols
41 Wide Awake
45 Ringlet
42 Revelation G.M. Co.
43 White Hope South Extended
44 White Hope South Blocks
49 Revelation South G.M.
46 Hampton Jubilee
47 White Hope South Blocks
51 Smiley's Special
52 Reserve
54 Radio
55 Kanowna
56 Bright Hope
59 Sailorman
60 Alchemist
61 Star of the South
63 Golden Hope West
64 Reserve
65 Hopeful
66 Maroubra
67 Allison Prospecting G.M. Co.
68 Revelation South G.M. Co.
70 Revelation Block 70
72 Hampton Triangle
74 White Ensign
76 Rug of Gold Opt. Syndicate
84 Reserve
83 Uruguay Hope
85 Revelation
86 Golden Hope
87 K.8
88 Reserve
91 ——
92 ——
94 Daisy May
95 Hampton Daisy
96 Daisy North
97 Groper
98 Red Indian
99 Reserve
102 Reserve
105 Star of the East
106 Daisy East
107 Reserve
110 Slavin's North Extended
111 Primrose
112 Cloth of Gold
113 White Hope Main Reef
116 Daisy North Extended
117 White Hope Gift
118 Wollubar Extended
122 Waverley
123 Kenilworth
124 Reserve
130 Hampton Mint
129 Goodalls
134 ——
136 Falcon West
138 ——
139 Reserve
141 Wollubar West
142 Wollubar West Extended
144 Dove
145 Dundee
147 Golden Victory
148 Hampton Daisy West
150 Rosella
154 Marouba
155 Old Brewer
156 Night Watch
157 Mistico
158 Ypres
159 Ypres West
161 Slavin's H.D. Extended
175 Hampton Boulder South
196 Golden Link
198 Golden Bond
202 Waverley Extended
207 Lancashire Lass
209 Lucky Mac
210 ——
211 Falcoln Extended
213 White Hope East
214 Kadina
215 Reserve
216 ——
219 Golden Victory

value from 5 to 40 dwt. per ton. The ore at a depth of 40 ft. is of higher grade than near to the surface. In the South shaft (No. 3) a cross-cut has been started at the 40 ft. level, and driven 7 ft., the average value being 35 dwt. per ton, with the face still in ore. At the No. 2 shaft, the cross-cut has been driven 11 ft. in ore worth 20 dwt., and is still in ore. At the No. 1 shaft, the cross-cut has just encountered the lode, and a bore-hole put in for 6 ft. gave an assay-value of 12 dwt. per ton. The distance between Nos. 1 and 3 shafts is 510 ft., and additional shafts will be sunk

White Hope No. 3 Shaft.

along the strike of the lode as exposed in the costeens to the north and south of these shafts.

Continuing on the same bearing for another six miles, all of which ground has been taken up, the Starlight group of leases is met with. Here the lode almost entirely consists of quartz over a width of 10 ft. to 40 ft. on the contact of the fine-grained greenstone with the granite porphyry. Small porphyry cross-fissures are found running through the quartz, and in the vicinity of these free gold can be seen in the quartz. Samples taken from such points assay up to 2 oz. per ton, whereas away from the fissures the assay-value of the lode is low.

There have been over five hundred leases taken up in Blocks 50 and 48, over half-a-mile in width in places. On about 25% of these prospecting work has been commenced. Encouraging prospects are said to have been made at other points along the main line, but these are not sufficiently developed to be worth recording at present. At three points on a line parallel to and east of the main line, other lodes carrying gold have been found, namely, on the Pernatty Lease, opposite the Celebration Lease, on the Mutooroo East adjoining the Mutooroo, and on the Deeps opposite the White Hope Lease. The discoveries on the three probable mines are good, those on the three just mentioned are promising, while the prospects on a number of other leases along the shear-zone are decidedly encouraging.

As the developments at the various centres along the line are carried out, a further description will be prepared, if possible with a geological map of Block 48.

Summarizing the above, the geological conditions are similar to those on the Boulder belt, and are favourable for the formation of ore-bodies at various points in these two blocks of the Hampton Properties and Areas respectively.

The managers who have been appointed to develop the main properties are sound mining engineers, and are supplied with sufficient capital by their companies to carry on intensive prospecting and development work, so as to rapidly test the value of this new field, which gives more promise of success than any other discovered since Kalgoorlie.

While the Hampton Properties and Areas companies are quite entitled to the alternate blocks, it is essential that they should "do their bit" in carrying out an extensive system of prospecting on the blocks which they have reserved for themselves.

The Geological Survey.—As already announced, the Geological Survey and the Museum of Practical Geology have been transferred from the Board of Education to the Department of Scientific and Industrial Research. A Geological Survey Board has now been appointed for the purpose of managing the work of the Survey and Museum, with power to make suggestions for extensions and improvements. We note with pleasure the presence of an active mining man on this new board in the person of Mr. Frank Merricks.

GREENHOW HILL LEAD MINES.

By W. W. VARVILL, M.C., B.Sc., Assoc.Inst.M.M.

The author describes an enterprise in Yorkshire, where mines containing galena, fluorspar and barytes are being reopened.

GREENHOW HILL is situated on the watershed between the rivers Nidd and Wharfe, in the West Riding of Yorkshire. The village to which the hill lends its name lies a little below, and to the north-east of the summit, on the main road between Ripon and Skipton. It claims to possess the highest church in the British Isles, and is notorious as being the highest and bleakest village in Yorkshire. The church stands 1,281 ft. above sea level, and some of the mines lie a little higher. The nearest railway is the North-Eastern, at Pateley Bridge, in Nidderdale, $3\frac{1}{2}$ miles from the village. The Midland Railway at Grassington, in Wharfedale, also serves the district, being 7 miles from the village. There is an excellent though hilly road from Pateley Bridge to Skipton, which runs right through the heart of the mining areas. The map herewith shows the position of Greenhow Hill, and Fig. 2 overleaf gives a larger-scale map of the property with the geology and outcrops.

Lead mining has been carried on at Greenhow intermittently from time immemorial. The mines were probably worked in Roman times, concrete evidence of this being obtained from a pig of lead found in 1735 stamped with the inscription: IMP. CAES: DOMITIANO AVG. COS: VII.—BRIG. There are many other evidences of very ancient workings. In recent times, that is to say, since 1800, mining was carried on continuously up till about 1890, when a complete stoppage took place, due principally to the low price of lead obtaining at the time, and also to the antiquated and costly hand-to-mouth methods of mining which were then employed. This stoppage was inevitably followed by the scrapping of such plant as was used, the migration of the mining population, and the caving of the old shafts and levels.

Apparently no plans or records of the mines were ever deposited in the Home Office, with the result that when the reopening of some of the mines was being considered prior to the war, the only data to work upon were the statements of the few old inhabitants who had stuck to the hill through its years of adversity. These statements, which as a rule should be accepted with reserve, have subsequently proved remarkably accurate as regards the lie of the veins and beds, although the untold easily-secured wealth confidently promised to any enterprising person who would reopen an old shaft has not been forthcoming. Hard work and much patience must be expended first.

The geological formation is the massive Carboniferous Limestone overlain by beds of shale

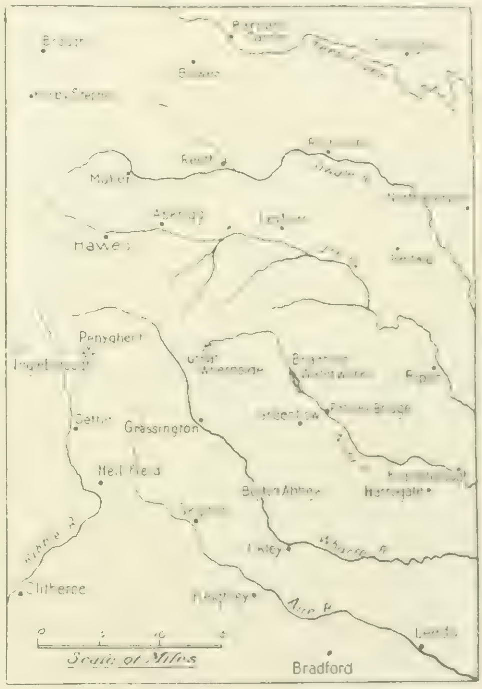


FIG. 1. MAP [illegible]
GREENHOW HILL LEAD MINE.

and grit of the Millstone Grit series. The exposure of the Carboniferous Limestone beds at a point so far east of the great Pennine anticline is due to an anticlinal fold, with an east-west axis, having thrown up the limestone beds so as to expose them, and form a tongue of limestone country, protruding into the surrounding area of shales and sandstones. The summit of this east-west anticline is not exposed west of Greenhow, because at the southern limit of limestone exposure the great Craven fault occurs which throws down the limestone beds to the south, bringing the grits and shales into unconformable contact with the limestone north of the fault. The Yoredale beds, which

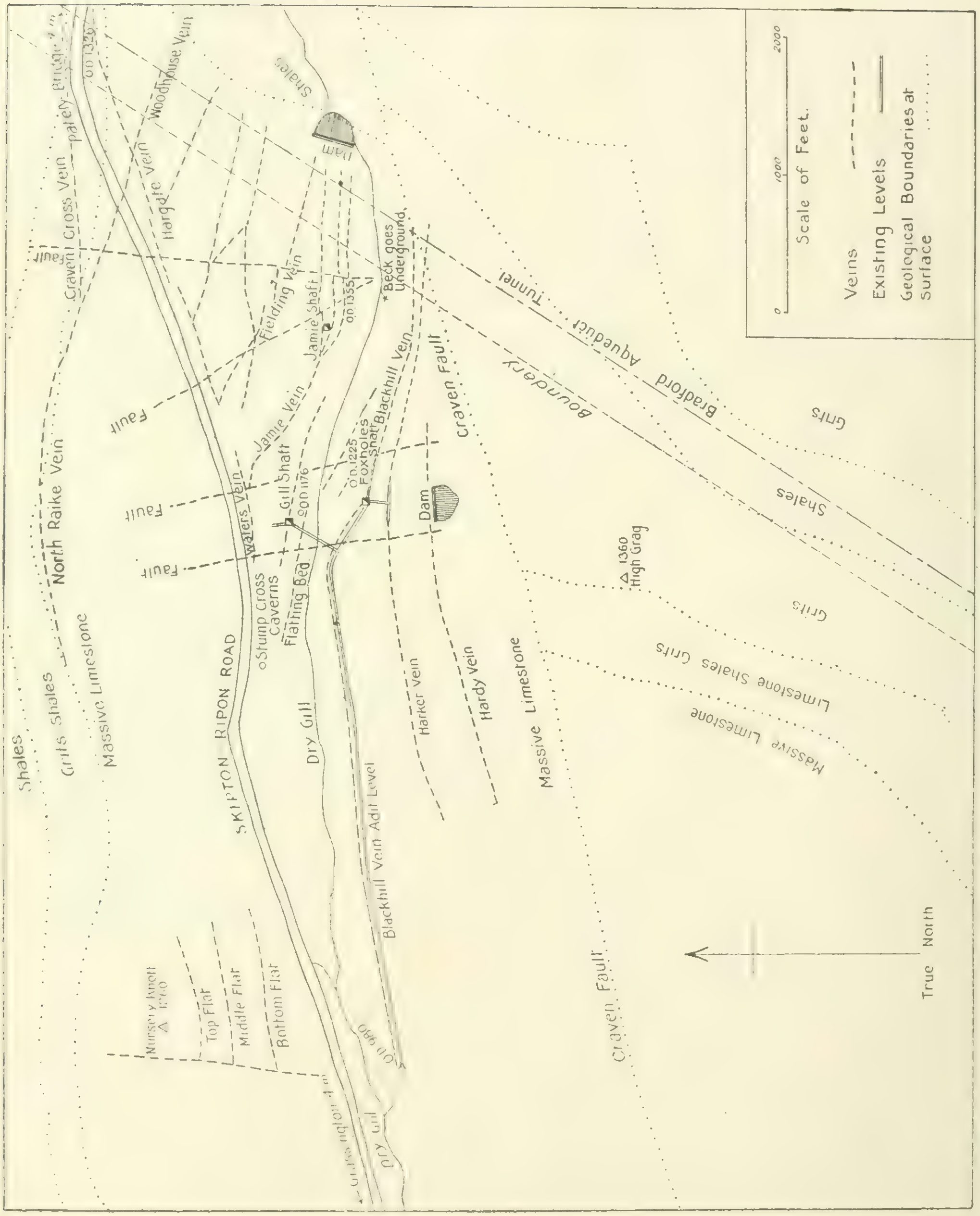


FIG. 2.—MAP OF THE GREENHOW HILL PROPERTIES, SHOWING OUTCROPS OF LODES AND THE GEOLOGY

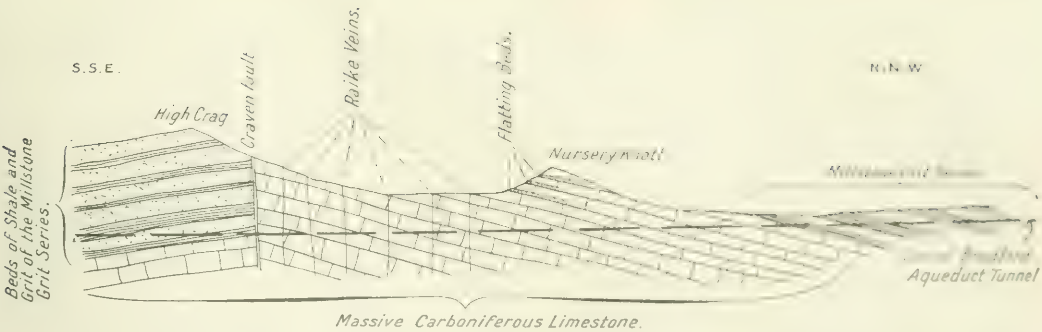


FIG. 3. -NORTH-SOUTH SECTION THROUGH GREENHOW HILL DISTRICT.

farther north in Upper Wharfedale and on Great Whernside consist of alternating beds of shales, grits, and limestone, have altered in nature farther south near the Craven fault, the beds of shale and grits having thinned out, leaving one massive bed of limestone of unknown depth.

Fig. 3 shows a north-south section through the district. Lead ore occurs in three distinct types of deposits, "raike" veins, "flatting" beds, and pipes.

It is the east-west fissures in this anticlinal fold that constitute the principal bearing veins of the district. These are locally known as "raike" veins. Their dip is variable, either to the north or south, but never more than a few degrees from the vertical. There is also a north-south series of fissures known as the "cross" or "gulph" veins, which as a rule do not bear lead ore, except near their intersection with a raike vein, although the most productive vein of the past at Greenhow, the Greenhow raike vein, is really a north-south vein.

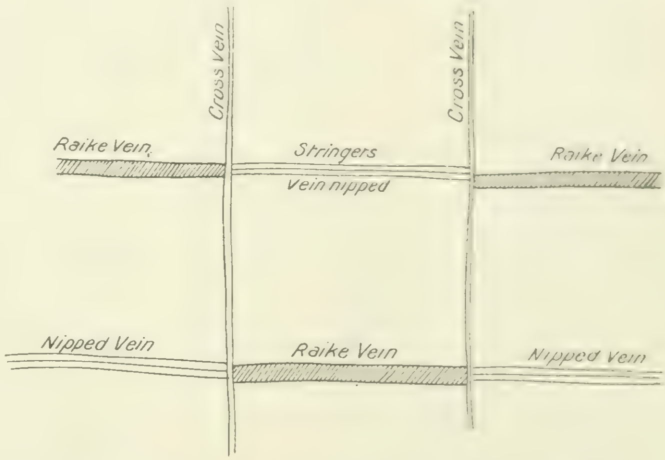


FIG. 4.—SHOWING ALTERNATE WIDE AND NIPPED PORTIONS OF THE VEINS.

The north-south veins sometimes throw the east-west veins a few feet, which points to their being a later series of fissures, though generally the throw is negligible. In the writer's opinion many of the faults, which are pointed out in the district as throwing the veins 40 or 50 ft. laterally, are not true faults at all, inasmuch as they often throw one vein to the north, while a parallel vein a few yards away they throw to the south, or do not throw it at all. The probable explanation for this would appear to be that the vein-forming solutions originally engaged in filling an east-west fissure, have come across a north-south fissure offering an easier route and have accordingly filled it for a certain distance, and then resumed their east-west course along another fissure parallel to the original one and a few yards away, thus producing the semblance of a fault. It sometimes happens that on encountering another north-south fissure the vein-filling runs back along it till it reaches its original strike and then takes up the old line again. This procedure probably accounts for the well-defined alternate wide and nipped portions of the veins that are so common. Fig. 4 shows the formation. This process is not only conspicuous in the vertical fissures, but also in the limestone bedding-planes. The veins frequently behave as shown in Fig. 5, when the process is known as "flatting."

As will be readily understood, the business of following a vein, which steps off to one side or the other at frequent intervals, is not an easy matter, especially when the problem is complicated by the flatting process in addition.

The above features, of course, are well known and common in limestone districts, but Greenhow Hill presents some excellent examples of how a vein ought not to behave from the miner's point of view. However, the saving feature of the district is the number of veins available for working. The whole mass of limestone is highly mineralized. Any north-south or east-west fissure or any bedding plane may be sufficiently mineralized to be worth working. Junctions of both east-west and north-south veins are common, and it is at such spots that the richest deposits of ore may be expected.

As a rule the veins only carry lead ore in payable quantites in the limestone beds. On passing up into the shales and grits they become impoverished. Exceptions to this rule, which holds good throughout the lead-mining districts of the North of England in the Carboniferous rocks, are conspicuous near Greenhow. At Merrifield mines, about 3 miles from Greenhow, the veins have only been worked in the shales and sandstone, and in the latter they proved very productive. They were never worked down as far as the limestone, so their value in depth remains to be proved.

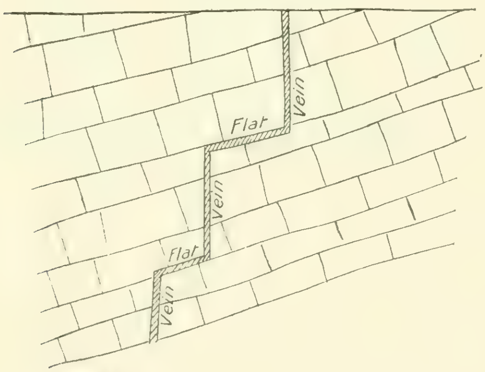


FIG. [illegible] DIAGRAM EXPLAINING "FLATTING."

The second type of deposit is the flatting bed. This consists of a mineralized bedding-plane that has been probably dissolved out in the neighbourhood of a fissure by water and subsequently filled by mineral-bearing solutions from below. They are generally thickest near vertical fissures, and are frequently very rich at their intersection with a "raike" vein. Occasionally the dissolving process has taken place without the subsequent mineralization process, with resultant caverns. On the property are caverns which would have made very fine flatting beds had they only been filled with mineral. They are, however, well provided with stalactites, and accordingly not wholly unproductive, as many hundreds of tourists are passed through in the summer on payment of a fee. Fig. 6 shows a typical flatting bed as shown at Nursery Knott mine, the gangue being largely of barytes and clay in places 5 or 6 ft. thick.

The third form of deposit of the district are the pipes. These pipes are irregular masses of mineral at the intersection of two veins or veinlets over a flatting bed. A typical example is Gill Shaft pipe. This contained a core of nearly solid galena, surrounded by barytes and fluor-spar mixed with galena, the galena becoming less frequent at the outer edges of the pipe. Fig. 7 shows a typical pipe in plan and section. Some of these pipes have been remarkably rich, and many small fortunes have been made by miners working them on their own.

The gangue of the veins consists of calcite, fluor-spar, and barytes. The lead ore generally occurs in well-defined ribs on one or other of the vein walls. Its immediate neighbouring gangue is generally fluor-spar.

The Greenhaugh Mining Company, which is at present working these mines, was formed in 1915. It commenced work in 1916, but owing to war conditions little progress was possible, owing to shortage of labour, etc., until the beginning of 1919. Since the latter date a definite development campaign has been instituted to prove the veins below the old workings.

Mr. H. J. L. Bruff, an engineer on the North Eastern Railway, was responsible for the formation of the present company, and for the commencement of operations. For some years prior to the war he had made an exhaustive study of the district when on his vacations, and before commencing operations consulted Professor Henry Louis, of Newcastle-on-Tyne, who now acts in a consulting capacity.

The region offers remarkable opportunities to an enterprising company that is prepared to develop vigorously and wait awhile before commencing to crush ore. The old mines have not been worked anything like so exhaustively as those in the Cardigan, Montgomery, Weardale, or Alston districts. They were rarely worked so deep that pumping was necessary, it being possible to work down to 20 fathoms in depth below the surface in summer without encountering much water.

Generally speaking the veins are so numerous that the old miners were able to abandon one vein as soon as they encountered water in any quantities, and start work on another vein on the surface.

Only in the latter half of the 19th century was any effort made to mine deeper with pumps and adit levels, and even so no greater depth than 72 fathoms below the surface was reached

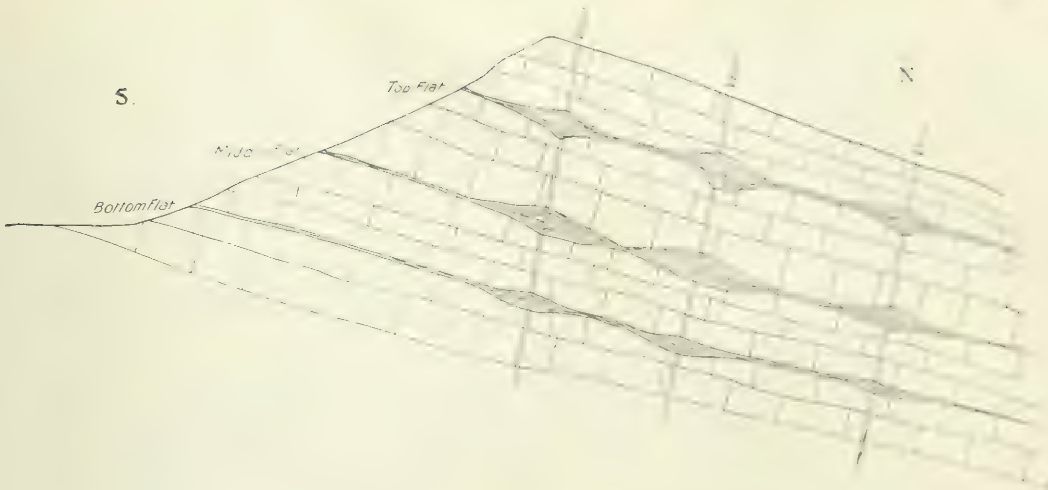


FIG. 6.—TYPICAL FLATTING BED AT NURSERY KNOTT.

on the present company's property, whose deepest workings at present are only 35 fathoms below the surface, and being drained to that depth by an adit.

No evidence has yet been forthcoming of any impoverishment in depth. The above-mentioned 72 fathom shaft is reputed to be as rich at the bottom as at the top, but this legend is too common in all mining districts to be reliable. Far more valuable evidence is afforded by the Bradford Corporation Aqueduct Tunnel. This tunnel, which was driven to bring water from the Nidderdale reservoirs into Wharfedale and thence to Bradford, constitutes the eastern boundary of the Greenhaugh Mining Co.'s property. It was completed about 10 years ago. Its length from end to end is 3½ miles. Through the greater part of its length it was driven through shales and sandstone beds, where lead-bearing veins were not to be expected. Only when reaching the limestone anticline already described did it enter the true lead-bearing ground. While passing through the limestone it cut in 3,500 ft. no less than 14 veins with an east-west strike. Of these 6 were bearing payable lead ore where the tunnel cut them and the remainder were not, though they were of a "kindly bearing" nature, which might easily bear on encountering a cross vein or branch vein. One of the veins cut, the Craven Cross vein, contained a rib of solid galena at least 1 ft. thick and yielded 11 tons of clean galena in lumps by simply driving the 7 ft. by 8 ft. tunnel heading through it, the smalls being allowed to go to waste. Two other veins, the Blackhill and Harker, which the present company is now working, were

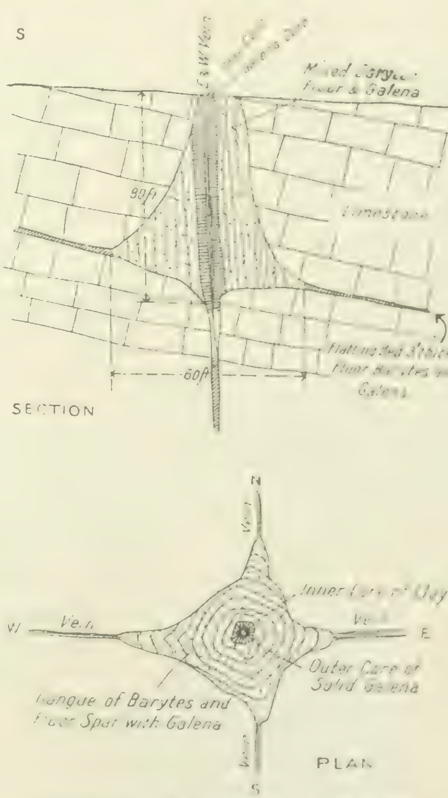


FIG. 7. TYPICAL PIPE IN PLAN AND SECTION

also very rich where the tunnel intersected them. The tunnel cut these veins from 400 ft. to 500 ft. below the surface, and so has proved the existence of payable lead ore well below the present mine bottom.

FIG. 8.—VIEW OF JAMIE SHAFT BUILDINGS IN WINTER.

The thickness of the Carboniferous Limestone is unknown, having never been bottomed in this district. It is probably over 1,000 ft. thick, judging from geological sections of adjacent districts.

From the above brief description it will be seen that there is ample scope for mining operations on a fairly large scale, given sufficient labour and adequate capital to place the enterprise on a sound footing. There are many features lending themselves to keeping mining costs low. The mines are served by a high-class road suitable for motor haulage to the railway 5 miles away. Pumping costs are nil, and likely to remain so for some years. The veins are soft and can be largely worked with a pick. The country rock is easily drilled and blasted and stands well, no timber being required. The ore is clean and easily dressed, and in no way complex. The mines are shallow. The veins in many places are virgin to within a few yards of the surface, and some in places to the surface itself. Fuel costs are at present heavy, coal being 50s. per ton at the mine, but steps are being taken to work a thin seam on the property and so render the mines independent of the collieries and all the troubles pertaining thereto, in addition to obtaining cheap fuel. During the coal strike last summer the boilers were kept under steam for 5 weeks solely on peat dug from the moor just outside the engine-house door, the long drought having dried it remarkably well.

Labour presents a difficulty at present. The hereditary mining population is practically extinct, so that recourse had to be made to any able-bodied man offering himself. The few remaining old miners, while valuable for their local knowledge, were too firmly wedded to the old methods of working with hand-drills and gunpowder to take kindly to pneumatic rock-drills and gelignite. They were wonderfully tough, however, and a party of dalesmen of the old school cleaned an old shaft that had run in full from top to bottom, 215 ft. deep, with no other tackle than a hand "jack-roll" or windlass, and two little wooden kibbles. They did this in winter on the hill-side 1,400 ft. up, the jack-roll men having to cling to the handles to prevent themselves being blown bodily off the job.

During the year 1919, the number of men engaged rose from 12 to 50. Most of the newcomers are demobilized soldiers, glad to take on any job. Some of them have made quite fair rock-drillers, and within three months of starting were driving a cross-cut in solid limestone at a foot per 8 hours shift.

Two old shafts have been reopened, and equipped with steam winding engines. The air-compressing plant is also steam driven. The compressors, of which there are two, are straight-line Ingersoll-Rand machines, giving respectively 80 and 250 cu. ft. per minute at 90 lb. pressure. The rock-drills used are wet-feed Ingersoll-Rand jack-hammers on cradle mountings. They are simple and light to handle and can be easily dismounted and used in the hand if required

Jamie shaft, the first to be reopened, is not yet connected to the adit level, and accordingly had to be kept unwatered with an Evans sinking pump. Very good ore was discovered under foot in two veins, the Jamie and Lonsdale, but the work was suspended until the adit could be driven up to take the water off, which it will eventually do a few feet below the present shaft bottom.

Foxholes shaft, 35 fathoms deep, was equipped temporarily with an old Fowler engine and guided kibble. The development headings from this shaft are at present four in number, as follows:

(1). Driving east on Blackhill vein at 35 fathoms. This is at adit level, and will eventually connect with Jamie shaft workings. The vein is virgin to the surface 100 yards east of the shaft. So far one ore-shoot has been driven through, being about 60 ft. long, averaging 12% lead over a stoping width of 30 inches.

(2). A cross-cut south from the shaft bottom to Harker vein with 15 fathoms of unworked backs.

(3). A cross-cut south from a point 200 ft. east of the shaft at the 35 fathom level along a north-south vein to cut Harker vein, with 35 fathoms of unworked backs.

(4). Cross-cutting north on Gill cross-cut to Willie Waters vein. This cross-cut has 60 yards to go and will cut the vein about 15 fathoms below the old workings.

Gill shaft has also been reopened. It has connection to Gill cross-cut, thereby ensuring a second exit and good ventilation. It has been straightened down to 20 fathoms and equipped with a Holman diagonal hoist driven by compressed air. The shaft is really a worked-out pipe, and has been sunk to a point about 5 fathoms below the main flatting bed. A heading has been started at 20 fathoms, driving along the bed which dips north-east at 15° to the horizontal and is about 3 ft. thick, consisting of fluor-spar, white barytes, and galena in payable quantities. It is hoped with this heading to locate further pipes.

In addition to the above workings an old flatting bed mine on Nursery Knott, about 1 mile farther west, has been reopened and an old incline drift down the bed is being cleared. It is proposed to work the barytes here which is very abundant, much of it being in the form of "deads" or old stope-fillings. This bed, which has been worked along its outcrop for about 300 yards by the old lead miners, consists of solid barytes with clay on top. The old miners only worked the lead ore where it occurred in patches, leaving the greater part of the bed intact in pillars. Some of these are 5 ft. high and of solid barytes. The bed dips at about 15° to the horizontal, and is free from water. Access has been made to a point about 200 ft. below the outcrop, but the old workings continue deeper than this.

The coal seam already mentioned occurs in an old lead mine adit level about 3 miles north-west of Greenhow. It lies in the shales immediately above the limestone, and has been worked in the past. Men are now engaged

Fig. 9.—View of Foxholes Shaft.

driving through the "gob" to the coal face, which is probably not far ahead. The seam is about 18 in. thick of fair quality caking coal.

There are countless other veins both on the company's property and outside it, many of which present equal opportunities to those at present being tried. A successful mining venture at Greenhow will do much to promote interest in the revival of the oldest industry in Yorkshire. There are innumerable other old lead workings not only in Nidderdale and Wharfedale, but in Swaledale, Uredale, Teesdale, and many another dale. Many of them consist of little more than surface workings and were abandoned long before railways appeared. Probably many of the outlying mines were abandoned for the simple reason that there were many others easier of access to be worked when railways first started to enter the dales. In these days of motor transport, many outlying mines could be worked profitably, which in former times had their output limited to the capacity of pack ponies.

Moreover, the old miner never had a marketable gangue to his ore, such as exists to-day in the form of fluor-spar and barytes. Some of the veins at Greenhow could be worked for these by-products alone, with profit. It is a thousand pities to see good British money being poured into worthless holes in the ground anywhere between Tierra-del-Fuego to Spitsbergen, while speculative properties of far more promise lie here at home, within a few miles of the greatest industrial district in the world. Perhaps the saying "what the eye doth not see the heart doth not grieve at" explains the attitude of many British speculators toward their overseas adventures.

THE DISTRIBUTION OF ORE IN DEPTH

With Special Reference to the Chances of Finding further Deposits of Hematite in the Cumberland-Furness District.

By J. D. KENDALL.

In "The Formation of Ore-bodies"* I have endeavoured to show that metallic minerals mainly came into existence in that zone of the earth's crust which, at the time of their deposition, was occupied by ground-water, the metals or metallic oxides rising in a gaseous condition from various depths in the barysphere and becoming dissolved in the acidulated ground-water, from which they were afterwards thrown down either by solids, such as limestone, or by liquids containing the necessary precipitants in solution. In the former case they replaced the solids; in the latter they were deposited in cavities of various shapes and sizes, though none of them were large.

The ground-water, then, doubtless varied greatly in depth, according to the geological structure, just as it does to-day. Along fault-planes or along coarsely clastic beds such as the conglomerates of the Keweenaw Peninsula on Lake Superior and the banket beds of the Transvaal it would probably reach great depths, and mineral deposits might in some cases occur down to those depths, provided the character of the ground was suitable, that is to say, if it were either calcareous or cellular.

In speculating on the probable depth to which mineral deposits may now be found, it must not be forgotten that those parts of the earth's crust which, at any time, have been above sea-level, have, throughout their aerial existence, been subjected to constant—sometimes severe—denudation, so that the depth of rock that has been removed in that way from any given area, since its metallic minerals were deposited, will depend upon the age of those minerals and how long the surface above them has been exposed to denudation. Some, like the hematite deposits of Cumberland and Lancashire, were probably deposited in early Permian days, and the areas in which they occur have been exposed to the action of denuding agents a great part of the time since. Other minerals, like the silver-lead ores of Leadville, Colorado, came into existence since the close of the Cretaceous period, while many gold deposits, like those of Cripple Creek, were formed in late or post-Tertiary times. The surface of both the Leadville and Cripple Creek areas has been continuously lowered, since the ores named came into existence.

The older a deposit is, the greater must be the thickness of overlying rock removed since that deposit was formed if the area has, in the meantime, been exposed to denudation. In some cases it may have been a few hundred feet only. In other areas it may have been thousands of feet. Clearly, therefore, in the exploration of a district, it is necessary to know the age of the deposits sought and the amount of erosion the overlying surface has undergone,

* Trans. Canadian Mining Institute, vol. xxi., 1918.

because, if my view is correct, it would be useless to search below the bottom of the ground-water zone at the time the deposits were formed. Other things being equal, the lower limit of that zone would sink as the surface of the ground above it was lowered, so that to-day it may be hundreds—perhaps thousands—of feet nearer the earth's centre than it was then. Its present depth is therefore no guide to the depth at which ore-bodies may be found.

Owing to denudation, ore-bodies are now much nearer the surface than when they were formed, which is fortunate for us, but many other deposits that were much nearer the surface at the time they were formed have doubtless either been greatly reduced in size or, more probably, been swept away altogether. When we meet with dish-like deposits such as those sometimes seen in West Cumberland, and frequently in Furness, we are not to conclude that they were formed so. They are rather the remains of deposits formed deep down in the Limestone, but now appearing near the surface in consequence of the enormous amount of denudation that has taken place since they were formed. The clay, black-muck, and sand that occur in some of them are later introductions, much of the clay being comparatively recent, as shown by its inclusion of fragments of existing species of timber. The following section, Fig. 1, will help to show how cavities may be formed in either the centre of an ore-body or between the ore and the surrounding Limestone and afterward be filled with clay, black-muck, or sand.

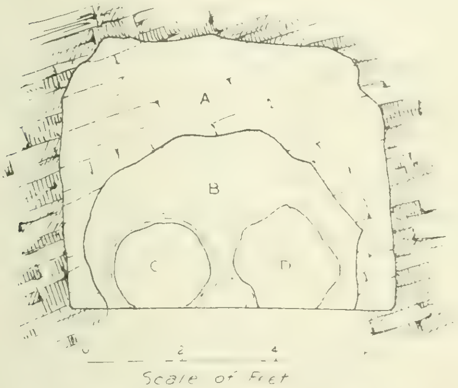


FIG. 1. A Limestone; B Clay; C and D Loughs.

This section occurred in No. 3 pit of the Salter Hall Mines, at a depth of 50 fathoms from the surface and 30 fathoms below the top of the Limestone. The clay adjoining the loughs was laminated, as it often is in the ore-deposits. It had evidently been deposited in a cavern at a time when the loughs A.B. were occupied by Limestone, which has since been dissolved, and some day, if left undisturbed, they might have been filled with sand or black-muck. Loughs occurring in ore may also be so filled, and doubtless in Furness have been so often.

Within the ground-water zone at the time the metalliferous deposits took place in any given district, distribution in depth depends entirely upon the existence of certain features of geological structure, such as faults, fracture-zones, dykes, and contacts of different kinds of rock, one of them being calcareous.

I will now endeavour to apply these general conclusions to the hematite deposits of Cumberland as occurring mainly between Winder Gill and Egremont. Fig. 2 is a vertical section between Winder Gill and Cleator Moor. Fig. 3 is a continuation of Fig. 2 on to Southam. Fig. 4 is a vertical section between Bigrigg and Egremont. The inclination of the Carboniferous and Permian beds and the thickness of the Grits and Coal Measures at different points along the lines of Figs. 2 and 3 are given in the following table :

	Inclination of Carboniferous Rocks	of Permians	[illegible] of Grits, &c. Feet.
Winder Gill	[illegible]	[illegible]	[illegible]
Parkside	[illegible]	[illegible]	[illegible]
Moor Row	[illegible]	9	[illegible]
Pallaflat	[illegible]	7	[illegible]

It will be noted that the inclination of both the Carboniferous rocks and the Permians becomes less and less from Winder Gill to Pallaflat; also that the thickness of the Grits and Lower Coal Measures is reduced in the same direction.

The base of the Carboniferous rocks at Yeathouse is 425 ft. above the Ordnance Datum. Between Moor Row and Bigrigg it is about 950 ft. below. At Gillfoot Park (Fig. 4) it is 80 ft. above that plane, and at Egremont it is 1,000 ft. below. That is to say, it is 1,375 ft. higher at Yeathouse than between Moor Row and Bigrigg, 345 ft. higher than at Gillfoot Park, and 1,425 ft. higher than at Egremont, although the surface difference is only 260 ft., it being that much lower at Egremont.

The hade of the faults between Winder Gill and Southam (Figs. 2 and 3) is, with three exceptions, in the same direction. That is toward the N.E. On the line of Fig. 4 they also hade N.E. as far as Gillfoot Park, but from there on to Egremont they hade in the opposite direction.

The facts mentioned in the three preceding paragraphs, with others that may be seen in the coalfield, point to a number of crust movements of primary importance to the district as a mineral producer. The first is a huge uplift which began, about the close of the Middle Coal Measure period, some distance south of Egremont and extended northward, in an increasing degree, to Gillfoot Park. From there to near Moor Row the upward movement decreased, but from the latter point on through the district to Rowrah it increased again. The increase probably continued for miles beyond Rowrah, in a north-easterly direction, reaching a maximum near the centre of the Skiddaw Slate area. The effect of the tensional strain put on the rocks by this uplift was to break up the continuous Carboniferous beds, and to fault and tilt them somewhat as shown in Figs. 2, 3, and 4, not at first to the extent there shown, because the uplift, the differential movements of the faults, and the inclinations of the strata were probably all increasing for a long time.

Following this period of faulting and tilting, and to a large extent contemporary with it, a long course of denudation set in, rock, hundreds of feet deep, being worn away by meteoric agencies. In some places, as for example at Gillfoot Park, as much as 1,000 ft. of Coal Measures, Grits, and Limestone may have been cleared off before the district was submerged again to receive the Upper Coal Measures (Whitehaven sandstone series). Another uplift, followed by more denudation and a second submergence, led to the deposition of the Permian Breccia. The district again rose out of the waters, the strata were further tilted, and the differential movements of the faults increased. Everywhere, over the hematite area, the Middle and Upper Coal Measures had been worn off, and in some cases the greater part of the Lower Coal Measures as well, prior to the Permian submergence. This we know from the way in which the Breccia is laid over the eroded edges of the Carboniferous strata.

I should not have thought it necessary to go so fully into this part of the district's geological history had it not been so strongly urged in the recently issued Memoir of the Geological Survey, on the hematite deposits of Cumberland and Lancashire, that the faults shown in Figs. 2, 3, and 4 did not come into existence until long after the Breccia was deposited. Had that idea corresponded with fact the base of the Carboniferous rocks at Gillfoot Park, instead of being as near the surface as it was when the Breccia was laid down, would have been at a very great depth, Gillfoot Park being almost at the full dip of the district.

The NE-SW fault which divides the coalfield from the ironfield and which, at Montreal No. 4 pit, has brought the middle beds of the Carboniferous Limestone up against the Middle Coal Measures, may have come into existence prior to the Upper Coal Measures being laid down, but if so it must have had one or more movements since, for I have made many attempts to find these latter rocks on the upside of the fault, but without success. They do not cross over it as the Breccia and St. Bees Sandstone do. The throw of this fault is 1,500 ft. at No. 4 Pit Montreal, but only 400 ft. at Crossfield No. 2 pit, the lower Grit-beds being placed alongside the middle beds of the Carboniferous Limestone. There are, however, two faults opposite the latter pit, parallel to the main one both in direction and hade. One, on the east of it and 290 ft. away, has a throw of 300 ft.; the other is about 1,000 ft. west, and has a throw of about 1,000 ft.

Since the uplift of the Breccia and its overlying Triassic rocks the district has probably been exposed to continuous erosive action.

In all probability none of the uplifts or the depressions alluded to had anything catastrophical in them, but were more or less continuous and extending through long periods of time. At which stage in these prolonged movements the hematite deposits were formed is not certain, but the fact of hematite occurring as a bed in the Upper Coal Measures at Millyeat and fragments of that ore being found in the Breccia, show that, in all probability, it came into existence between late Carboniferous and early Permian times. Denudation had then been at work on the rocks part of the time since the disturbance which took place about the close of the Middle Coal Measure period, but when the ore-bodies were formed the district would be everywhere overlain by Grits and Coal Measures which, in some places, might be well over 1,000 ft. thick.

The thickness of the whole of the Carboniferous rocks is about 3,000 ft., but part of that thickness having been worn away when the ore was formed, the ground-water zone would then probably extend below the base of the Carboniferous Limestone on the fault-planes, in several, if not in all, parts of the district. There are, however, some facts of distribution which may seem to throw doubt on this point. Ore has been worked in the bottom beds of the Seventh Limestone in several parts of the south-western end of the district, but only at one place has an ore-body been

FIG. 2.

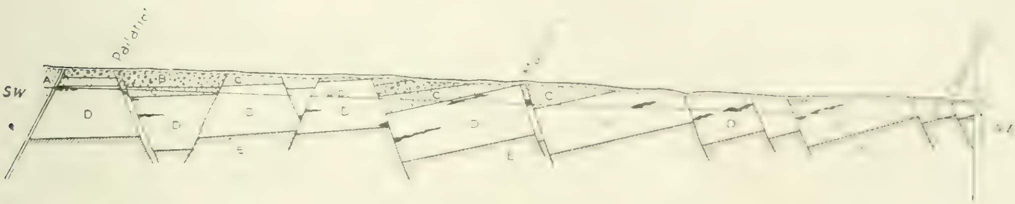


FIG. 3.

REFERENCES TO FIGS 2.3 & 4

A St Bees Sandstone.
B Breccia.
C Millstone Grit.
D Carboniferous Limestone
E Skiddaw Slate.
Hematite.

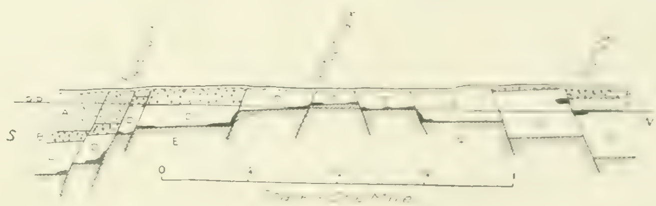


FIG. 4.

found in those beds where the full thickness of the Limestone series is on. That is at Woodend. In the north-eastern part of the district iron ore has only been worked in the bottom beds at Parkside.

Usually, in the areas covered by Millstone Grit and sometimes by Lower Coal Measures as well, the deposits are found in the First and Second or Third and Fourth Limestones. Where the Grits and Upper beds of Limestone have been removed, as in the neighbourhood of Egremont and along the River Ehen as far as Woodend, the ore occurs mainly in the Seventh Limestone. In other parts of the district where there is still a good deal of Limestone but no Grits, as at Eskett Park No. 5 pit and Postlethwaite's Eskett pit, ore has been worked in the Fifth and Sixth Limestones. How is this seeming difference of distribution to be accounted for? Did the ground-water not extend to the bottom of the Limestone series, in places, owing to the great thickness of the overlying arenaceous and argillaceous rocks, or why has not ore been found in the lower beds in every part of the district? All ground-water was originally rain-water and some of it may have been many times in the clouds. The depth to which it descends in the earth's crust depends upon the nature of the rocks and the extent to which they have been fractured. It will sink much deeper in calcareous and arenaceous rocks than in those that are argillaceous, and as the Coal Measures consist largely of the latter rocks it is possible their extra thickness over the Limestone in the north-eastern part of the district might have prevented the ground-water reaching the bottom of the Limestone at those places. An examination of the table above and of Figs. 2 and 3 will show that, to-day, the argillaceous rocks overlying the Limestones are much thicker in the north-eastern part of the district than at the south-western end. There are, however, two answers to the question outside that suggesting the possible absence of ground-water. The first is that we know the Limestone in some places has been so silicified that its replacement by an iron solution could hardly take place, and that might have been the state of some of the lower beds in those parts of the district where ore is not known to exist in them, but it is scarcely likely that it would be so in all. The most probable answer is that by the old haphazard, methodless efforts of searching these lower beds have never been reached in the proper place.

In the early days of mining, and up to within the last 30 years, explorations had seldom been carried deeper into the Limestone than about 300 ft., and very often they stopped much short of that depth, even where all the beds were on. When the district contained numerous large and shallow ore-bodies it was a comparatively simple matter to find ore, even in the unmethodical way then followed. But now that the shallow deposits have been exhausted it has become a much more serious affair ; much more costly and therefore less likely to be successful if the old way of working be followed, because the holes would not be so numerous, on account of the expense.

The mining experience of the last 60 years has shown that ore-bodies are invariably associated with faults, and therefore the method of search to be followed is to locate the bores in such positions that they will be close to the faults when they reach the horizon to be tested. In this way the positions of the bores will vary with the different horizons. It was thought at one time to be sufficient to "go to the Slate," regardless of the position, provided they were within the Limestone area. But that is not so, particularly in the northern end of the district where the faults are often much farther apart than they are around Egremont. We must go to the Slate at the right place, and then only in search of deposits in the bottom beds of Limestone. There is no need to go to the Slate if the hole is properly set out to explore either the Fifth or the Sixth Limestone or any other Limestone above those, for the simple reason that if a bore-hole is properly located for one horizon it might, and almost certainly would, be quite wrong for the other. Bores have been put down to the Slate in hundreds without success, because they were not put down at the right place. They never had a chance of meeting with ore on that horizon, as might easily have been known before they were started, by a study of the geological structure.

The deep bores needed for the work mentioned may, now and again, necessitate a rearrangement of the areas at present taken up, or of the interests of intending explorers, as it may sometimes happen that the most suitable place for a bore-hole is close to a boundary, and no prudent lessee would put down a bore in such a position.

An inspection of Figs. 2, 3, and 4 will show what a large number of places there are in which ore has not yet been worked in the lower beds of Limestone, and there are many other places outside those traversed by these sections quite as likely, both within the usually recognized hematite area and beyond it.

NEWS LETTERS.

ORURO, BOLIVIA.

February 20.

IMPRESSIONS OF BOLIVIA.—A few impressions of a mining engineer who visits this country for the first time may be of interest to your readers.

Without prejudice, Bolivia is not a civilized country. The native of the highlands, the progressive part of Bolivia, where all the mines are, is the Indian, either Quechua or Aymara, of the same race as the ancient Incas. He is far more of a savage than the African nigger, and still farther from civilization than the Hausa, Swaheli, or Zulu types. When I was young I read Prescott and had always imagined all sorts of wonderful things about the Inca Empire ; I am now forced to the conclusion that Prescott was a gentleman with a too vivid imagination and a far too easy flowing pen. In the East and many parts of Africa there is always some sort of aristocracy, and a faint echo in their customs that makes the white man realize that those peoples had a civilization when his ancestors were going about in woad and little else ; but these natives, in spite of Inca Empires and Spanish colonization, are just unwashed, ignorant savages. Few of them speak Spanish, not even all those that work in and about the mines. They live mostly in small agricultural communities of not more than thirty or forty persons, cultivate a little land, keep flocks of llamas, goats, and sheep, are dirty and extraordinarily ignorant and superstitious, and above all everlastingly chew "coca," which dulls what little intellect they have.

This type forms about 70% of the population of the high regions of Bolivia, the remainder being "Cholos," the local half-breed, with a sprinkling of whites of all nationalities.

The only people who can perform manual labour in these altitudes are the Indians and some Cholos. This is not surprising when you realize that many of the mines are from two-and-a-half to three miles above sea-level. To the European, shortness of breath and headaches are chronic, and it seems to affect the memory also. The daily output of the average Indian at his best is about a quarter of a white labourer's in a white man's country. Each man will draw according to the district, class of work, etc., 2 to 3 Bolivianos a day (at present a Bol. is worth 26 pence). He needs it all, for living is both dear and bad. It is impossible to vary one's diet. This is not to be wondered at in a landscape composed of bare rock with a few mosses and mountain grasses. By the bye, it is sheer cruelty to bring white woman to these places, yet of course you meet some.

The mines are rarely under the control of gringoes, though those of any size usually have a European or American engineer on their staff, really because there are no natives who can undertake a genuinely technical job. The owners are mostly Bolivians or Chileans and the boss generally of the same race, with the notable exception of the Aramayo-Francke group, which lies to the south of this district and which is run by British staffs on proper lines. Curiously enough the average responsible native engaged in mining cannot see the need of a white engineer. Their ideas are truly South-American. To them by far the most important side of mining is the commercial-political aspect, in other words, graft of all kinds; by which they make much money and gain influence. Graft, intrigue, and political interest occupy all the time of the native manager; the extraction of the mineral by the most economical method is quite a secondary consideration. We are still in the brave old days here, when they fought and died for their mines. Quite true! There is a friend of mine, an American engineer, who recently spent almost a month preparing his mine against his neighbours. He was proud of the fact that he could blow up and close all communications between the two properties at five minutes' notice.

As regards modern methods, consider what are probably the two richest tin-lode mines in the world, Llallagua and Uncia, the first a Chilean concern, the second Bolivian. Llallagua, after thirty years of production, is becoming modernized; it is now almost completely staffed by Americans; it has drainage tunnels and assay plans; but still only works an 8% ore, possibly because at present there is enough not to touch lower grades. Uncia is a curious mixture of the ultra-modern and the archaic; it has beautiful electric locos to enter the mine by its magnificent stone-arched adit, but there are no proper mine plans kept up-to-date, and, of course, no assay plans. Again, it has a huge office staff, but an uneducated native assayer; he has picked up assaying from gringoes, but he can't read chemistry books very well. A grocer with a tin-opener and a corkscrew could make profits out of either mine.

An illustration of the typical attitude of mind of the Bolivian manager is the following. A rather well-informed one told his engineer to get out plans for the ingenio (concentration plant) of an old mine being re opened; but, said the engineer, "Until we have sampled the mine and seen what class of ore we have to treat, how is that possible?" "O, never mind that, get out plans for treating all kinds of ore," was the answer of the manager, who really thinks he is a technical man.

Material is a terrible problem up here, fuel especially! If a mine is any distance from the railway it means pack animals or more rarely carts. A twenty-league journey by mules averages 5s. a load weighing 110 lb. Carting ordinarily costs a little more than double mule-transport. Timber is all imported from the United States, although like Brazil, Venezuela, and Colombia this country has an enormous forest belt full of valuable timber; lack of railways and roads accounts for this.

Another matter, not exactly mining, but of great interest to the mining communities, is the cost of food-stuffs. To the east of this country, sugar, rice, some wheat, and tobacco are grown cheaply, but up here we eat sugar from Peru, rice from China and India, flour from Chile and Argentina; the tobacco that we smoke truly is produced in the country, but what a price! All the foods have heavy duties imposed upon them. Why can't the Government of a country so potentially rich, apart from its minerals, raise foreign loans to make roads, railways, and generally develop its resources? They have no cattle industry on any scale, yet there are large tracts of plains quite as suitable as the cattle country in Argentina.

However, unlike their neighbours, they are not a progressive race; they cripple industries with heavy "impuestas" to raise revenue. There are few schools, none for the Indians; in fact there is no evidence of any attempt to civilize them. Perhaps the powers that be are right and it really is impossible.

Of mining news there is not much available. The railway to Uncia, passing Llallagua and Huanuni, which links up with the main system at Machacamarca, should be completed in eight or nine months; it is owned by Patiño. The Guggenheims are busy here; in the Quimsa Cruces district they have bought a fairly well-developed tin mine called Carecoles. It is reputed to be richer than Llallagua and Uncia together, with veins 50 cm. wide going 15 to 18%. They are said to have paid £1,000,000 down for it and to have already in the country material for making a railroad to link up with the Oruro main line. The same house are said, on good authority, to be buying up Potosi Hill to treat the silver and tin ores and dumps on a grand scale.

A small boom has started in buying options on properties of every kind, mainly with the idea of getting rid of them again at a profit. At one or two properties where a complex ore of galena, silver, blende, tin, and other minerals is mined, flotation is being introduced. Several metallurgists are experimenting on the flotation of tin; some want to consider it as a gangue and others as a flotable mineral.

From this letter you may possibly conclude that I don't like Bolivia. You'll be right. I'd sooner shovel snow or sling hash in a decent country than own this rotten desert. At the same time I haven't exaggerated at all.

In conclusion, there seems to be a sort of impression in Europe that Bolivia is a new country from the mining point of view. Of course this is emphatically not so. It has been scratched about for hundreds of years, so that apart from mines left alone because existing methods and small capital can't work them, and certain highly inaccessible and climatically bad regions, there is nothing much to look for. Being largely bare rock and not too precipitous it is a very easily prospected country from the visual point of view.

MELBOURNE.

March 6.

"WHAT IS THE MATTER WITH AUSTRALIAN MINING?" is the the title of a paper by Mr. F. Danvers Power, published in the latest issue of the *Proceedings* of the Australasian Institute of Mining and Metallurgy, dated December 31, 1919. Mr. Power regrets that "the old-time prospector of the Philosopher Smith type, who discovered the Mount Bischoff tin mine in Tasmania, is becoming past history," and that the present-day prospector, when he comes upon large low-grade deposits, too big for him to work for himself, rather than take the comparatively small reward which would be paid by a company which would have to work for years to open it out and expend a large sum on development and equipment, or, as he would put it, rather than run the risk of being swindled by the capitalist, prefers to leave it alone and say nothing about it. "If individuals will not carry out this class of work," says the author, "then syndicates, companies, or even the Government must do so, unless we are to allow the mineral assets of the country to lie dormant while our industries depend upon imported metals." He asks for systematic prospecting under properly trained mining geologists, and adds: "If this work is carried out by private enterprise, then the Government should make it worth the while of individuals by framing suitable laws. If the Government carries out the work, no better way could be found to spend the prospecting vote, for the money of the taxpayer would be better spent in that manner than by doling it out in order to artificially support forlorn hopes." He urges the Institute to take the matter up. "If the Government undertook to systematically prospect the country it could then charge a higher royalty to those who worked anything it discovered, and so recoup its prospecting expenditure. . . . . Money would be well spent in discovering the existence of valuable mineral deposits to be leased to others, for by so doing not only is a valuable national asset made available, but its extraction finds employment for miners and those dependent on them." With respect to State ownership of mines, he points out that the men who are qualified to be bosses now are the same men who would be bosses if the Government took over the various industries on behalf of the people. "The actual ownership is merely a side issue; it is the conditions that count," and monopolies owned by Governments have not hitherto produced results as favourable as businesses run by individual enterprise. "The average individual will not work so well for his country as he will for himself." The Government, he says, should "allow liberal areas and conditions to those who are prepared to prospect and work systematically. . . . The day of rich deposits is passing, or passed; so terms must be granted that will encourage those with money to develop and work large low-grade deposits, if mining in Australia is to continue." In the discussion which followed, Professor E. W. Skeats, of Melbourne University, mentioned that in the United States and in Canada schools of mining geologists were permanently attached to big mining enterprises, railway companies, &c. The position in Australia in that respect was lamentable. He had tried to train economic geologists, but had received no encouragement. None of the big mining corporations, except Mount Morgan, had taken up that work. He referred to the valuable work of Dr. Stillwell on the Bendigo field in the localization of gold-bearing shoots and to his present research work on the Broken Hill field. The time was ripe, he said, for companies in Australia to consider their attitude. Mr. William Poole (Sydney) commented spiritedly on the constitution of the State Advisory Committee of the Council of Science and Industry. Some of these, he said, did not contain any member who, by training or association, had any personal knowledge of the mineral industry, which was so important and vital to the well-being of the Commonwealth. In New South Wales, a State whose mining interests are pre-eminent in the Commonwealth, until very recently, when Mr. A. J. Gibson, late Professor of Engineering of Queensland University, took up his residence in New South Wales, the Advisory Committee did not contain a single member representative of the mining, manufacturing, and engineering industries, and the same was true of other States. At a later stage Mr. Poole referred to the Geological Survey staffs and their working policies in several States. Most of the men appointed to the Geological Survey staff in New South Wales prior to 1896 possessed a systematic academic training in geology and collateral science. The Public Service Commission was appointed in that year, and early introduced a scheme in which admission to the professional service should be as probationary cadet trainees upon a small pittance of salary. University graduates of undoubtedly high training and ability were to be put on the same footing as a lad direct from school. The result had been that although the University of Sydney, under the training of Professor Edgeworth David and other members of the staff, has turned out graduates who have done conspicuously fine geological work throughout Australasia, nevertheless, not one such man has entered the New South Wales Geological Survey. In fairness, however, he stated that many who had entered as raw probationers have become eminent as field geologists, but this was a tribute to the personality, determination, and ability of the individual rather than to a very defective system. Mr. Poole also criticized severely the perfunctory manner in which the policy of Geological Surveys had been carried on by the States' Governments. The Geological Survey of Victoria was dropped many years ago "for political reasons" and the staff was disbanded. "It has been mostly the custom throughout the Commonwealth merely to examine those fields or single deposits where difficulties threaten the existence or establishment of profitable mining operations. So long as the field or locality was prospering it was seldom that anything was done, except perhaps a hurried 'inspection of curiosity.' Many of the geological surveys of well-known fields were *pre-mortem* examinations to ascertain if life could be prolonged. Charters Towers—which, after Kalgoorlie and Bendigo, had produced more gold than any other field in Australia—was not examined underground until nearly all the well-known mines were quite defunct, or at least had ceased to be active producers. The same thing in a less degree occurred at Gympie. The Cobar field was not systematically examined until the industry was in a very critical condition. Broken Hill was examined over 20 years ago during its juvenile prosperity, but it was apparently studiously avoided until quite recently, when its future continuance as a large centre became a serious industrial and political question. . . . . Lack of appreciation of the value of practical geology has led many companies to waste their resources in useless work or to overlook valuable features. All material which was not ore was classified as 'mulluck' at Broken Hill. Garnet sandstone was not considered to be lode material until Mr. J. C. Moulden, at the Junction mine, drove through a body of it and developed valuable sulphide ore, the existence of which was not suspected by previous management."

AUSTRALIAN INSTITUTE OF SCIENCE AND INDUSTRY.—The Governor-General's speech at the opening of the Federal Parliament last week announced that it is proposed "to proceed with the Bill to constitute an institute of science and industry." It is amazing that so little enthusiasm has been shown respecting this very important step; in some quarters it was hailed on its first promulgation with some show of expectancy, and it is not unlikely that subsequent neglect is largely attributable to the fact that the air is full of strikes and threats of strikes; that at least is the most charitable view to take of the situation. Yet the institution is already partially existent, and has done some good work of a miscellaneous character. The initial obstacle to its complete formation was the difficulty of securing co-operation between States' and the Commonwealth Governments, the New South Wales Government being the chief offender. Some of the States are co-operating, and an endeavour has been made to so combine the institute's work with that previously going forward under State controls that there shall be no overlapping and no clash of interests. It is strange that after twenty years of federation, which was to have done away with rivalry (not competition) between the States, there should still be so much petty jealousy that it would shame a couple of school-boys with a fancy for one girl. For the most part the scheme is regarded in a friendly way, and universities and technical schools are entering into it, and, given a fair period of release from turmoil, it is conceivable that something approaching heartiness may even yet be infused into the industrial circles most interested. As things are, however, no "captain of industry" knows how soon his works may be closed for him, and therefore has, for the moment, something else to think of besides improving his methods.

GOLD DEPOSITION IN THE BENDIGO GOLDFIELD. — The Commonwealth "Advisory Council of Science and Industry" has just issued Bulletin No. 16 giving the results of the third year's investigation by Dr. F. L. Stillwell of the "Factors Influencing Gold Deposition in the Bendigo Goldfield." The Gold Research Committee, consisting of Professor E. W. Skeats, D.Sc., F.G.S. (chairman), and Messrs. E. C. E. Dyason, B.Sc., B.M.E., H. Herman, B.C.E.,M.M.E.,F.G.S., and F. L. Stillwell, D.Sc., in a covering letter, recommends the publication of the report, with accompanying plates and text figures, and proceeds :—"Prominent members of the mining industry and associations connected therewith have closely followed Dr. Stillwell's work throughout, and have acknowledged that, as a result of it, a much clearer perspective of the nature of the quartz reefs and gold shoots has been developed, and that his work will have an important bearing in guiding the prospecting activities on the Bendigo Goldfield. In these opinions the committee concur, and consider that the work will be specially valuable at this time, when the industry is suffering very severely from unfavourable economic conditions, and, consequently, is in need of all the technical assistance possible." The committee does not "recommend an immediate continuance of the work, believing that a reasonable period should be allowed to elapse for the assimilation and testing of the conclusions advanced by Dr. Stillwell; but it is of the opinion that at a subsequent date it will be found profitable to continue the work initiated by Dr. Stillwell, either by the institute or by joint action on the part of the industry. As previously pointed out by the committee, both the credit and the responsibility for the investigation are Dr. Stillwell's, but the remaining members of the committee place on record their appreciation of the thorough and scientific manner in which the investigation has been conducted by him." It is added that "during the last year Dr. Stillwell spent some time investigating the ore occurrences at the antimony mines at Costerfield, and he is preparing for later publication a report on this district as a small bulletin." It is now announced that Dr. Stillwell has accepted the position as mining geologist to the Bendigo Amalgamated Goldfields Co., in succession to the late Mr. Victor Dabst.

TORONTO.

April 13.

PORCUPINE.—Labour conditions in this and the other gold districts have greatly improved owing to the action of the mine managers in increasing wages and putting the labourers on an equality with those of the silver mines. Under the new schedule loaders receive $4·25 per day, and machine runners $4·75, with a corresponding increase to mill and surface men. This has tended to allay the prevalent feeling of unrest, and the relations between the operators and their employees are now generally satisfactory and harmonious. The McIntyre workings have reached a greater depth than those of any other mine in the district. The shaft is now down 1,550 ft. and will be sunk to the 2,000 ft. level. Vein No. 5, cut at the 1,250 ft. level, shows 14 ft. of high-grade ore with higher gold content than on the upper levels. Cross-cutting to tap this vein is being carried on at the 1,375 ft. and 1,500 ft. levels. The assay-values are running $11 per ton, and about 600 tons is being treated daily. The Hollinger is arranging to develop its Miller-Middleton property, the western portion of its holdings, where a number of surface veins have been uncovered and others encountered by diamond-drilling. One large deposit which has been partly developed is expected to yield a large tonnage. The Dome Mines has declared a 2½% dividend, the second to be paid this year. Before the closing down on account of the war the company paid 5% quarterly, but under present conditions it is hardly likely that this scale of disbursements will be renewed until the company has accumulated a large surplus. The annual statement of the Davidson is somewhat of a disappointment in view of previous official statements. During 1919 the mill treated 3,831 tons of ore, with an average recovery of $7·07 per ton. The directors of the Porcupine Crown and Thompson-Krist companies have arranged a merger, which will involve the formation of a new company capitalized at $3,000,000, of which Porcupine

Crown shareholders will be allotted $2,000,000 and Thompson-Krist shareholders $1,000,000.

KIRKLAND LAKE.—The Lake Shore during February produced $40,126 from the treatment of 1,435 tons of ore, being an average extraction of $27·96 per ton. Official figures show that during 1919 the Teck-Hughes produced $169,590 from the treatment of 18,387 tons of ore, being an extraction of $9·22 per ton. The production of the Kirkland Lake mine during 1919 from 11,324 tons of ore, mainly ore extracted in the course of development, was $55,780. The Bidgood has let a contract for the sinking of a 300 ft. shaft and 2,000 ft. of lateral work at that level. Work on the Canadian-Kirkland has been discontinued, cross-cutting on the 150 ft. level having failed to tap the vein which dipped out of the shaft at the depth of 80 ft. Diamond-drilling will be undertaken. At the Ontario-Kirkland the shaft is being put down from the 300 ft. level to 450 ft., at which level lateral work to develop good veins encountered on the 300 ft. level will be carried on. Construction work on the Wright-Hargraves mill, with a capacity of 150 tons per day, will be resumed about the end of the month.

COBALT.—The annual financial statements of the leading mining companies indicate that in nearly all cases their position has been considerably improved during the past year. The conservative policy of accumulating large surpluses rather than paying high dividends is being generally followed, with the object, in the case of some of the older companies, of buying new properties in anticipation of the exhaustion of their ore reserves. The annual report of the Nipissing shows a production of 2,905,476 oz. with a net operating profit of $2,717,312. The cost of production was 35·6 cents per oz., compared with 39·02 cents in 1918. Dividends aggregating $1,800,000 were paid, and the surplus increased from $3,441,702 to $4,372,952. The ore reserves were estimated at 6,354,656 oz., an increase of about 350,000 oz. During March, the Nipissing mined ore of an estimated value of $384,723, and shipped bullion from Nipissing and custom ore of an estimated value of $136,771. The annual statement of the La Rose indicated some improvement. The production for the year was 289,317 oz., valued at $356,124. The net profits were $51,736, as compared with $45,544 in 1918, and the surplus had increased from $456,046 to $514,424. The University and Princess properties were worked with good results. The McKinley-Darragh had a satisfactory year, net profits showing an increase from $308,718 to $354,128. The high price of silver made a considerable amount of ore available which formerly could not be mined at a profit, increasing the ore reserves to 1,077,411 oz. Since the report was issued, an important new vein has been found on the 350 ft. level. The Beaver Consolidated, during the year ended February 29, produced 301,781 oz. of silver with operating profits of $158,215. This company is working over ground that was previously regarded as exhausted, and is taking out large quantities of milling ore. Additions and improvements to the mill of the Temiskaming have enabled the company to largely increase production. The mill is now treating 100 tons of ore daily. The Kerr Lake has acquired some important outside properties, including a controlling interest in a producing silver mine in Utah, and a gold-dredging property in New Zealand. At the Oxford-Cobalt, sinking has been started on a promising vein. Another vein, carrying high-grade ore, has been found on the surface.

WEST SHINING TREE.—The shareholders of the Wasapika have ratified the reorganization proposed by the directors, involving the acquisition of additional holdings and the formation of a new company to be known as the Wasapika Consolidated, capitalized at $6,000,000. Each shareholder will receive three shares in the new company for each share of the old one. Tests of the ore from the Atlas mine having proved it to be of very high grade, the company has decided to build an amalgamation mill of about 60 tons capacity, saving the tailings for future treatment by cyanide process. At the West Tree, No. 2 shaft is down 70 ft. and will be sunk to the 200 ft. level. Shaft No. 1 will be put down to the same depth and connected with it by a drift 450 ft. in length. The White Rock is bringing in machinery preparatory to sinking. The Herrick, after expending $28,000 in diamond-drilling, has installed a large modern mining plant.

MATACHEWAN.—Satisfactory progress is being made with the development of electric power on the Montreal River, which is expected to greatly stimulate the progress of this camp. Little active work is being done in the meantime, with the exception of diamond-drilling. A contract for 4,000 ft. of drilling has been let by the Matachewan Gold Mines, and similar work is being carried on at the Lake Matachewan property adjoining, the results from which are stated to be satisfactory.

CAMBORNE.

SOUTH CROFTY.—The net profit (that is, after writing off depreciation on buildings, plant, and investments of £3,189) for 1919 was only £300, and this reflects the lower content of the ore treated and the reduced prices realized for the minerals produced. The following figures will be of interest:

	1918	1919
Tonnage milled	67,588	68,056
Tin recovered, tons	581	546
Value	£113,043	£77,724
Lb. per ton milled	19·26	17·96
Value per ton milled	33s. 5d.	32s. 10d.
Wolfram recovered, tons	72	59
Value	£12,522	£5,119
Lb. per ton milled	2·38	1·94
Value per ton milled	3s. 8d.	1s. 6d.
Arsenic recovered, tons	562	632
Value	£69,300	£30,522
Lb. per ton milled	18·63	20·79
Value per ton milled	20s. 6d.	8s. 11d.
Total value per ton milled	57s. 9d.	33s. 3d.
Working cost at mine per ton milled	34s. 10d.	30s. 0d.

It will be noted that there was an increase of 468 in the tonnage handled, and this was secured in spite of the fact that the net running time of the battery was 12½ days less; this is evidence of Mr. Blight's careful supervision of the plant. The lower operating cost was due to the cessation of bonuses to the employees. The development was 3,554 ft., which compares with 3,572 ft. for the previous year. The most important exploratory work was carried out at the 290 fm. level, where a cross-cut was put out to intersect the two lodes revealed by diamond-drilling in the previous year. The North lode intersected at this level has so far been left undeveloped, but Mr. Paull expects a continuity of payable values at this point, as the lode has already been proved at the 245 and 260 fm. levels. The second lode intersected appears to be most promising and, for the 95 ft. driven, has averaged 35 lb. black tin per ton for a width of 5 ft. On the whole the general milling average of ore opened up has been maintained. Further efforts are to be made this year to locate the now famous Rogers lode by diamond-drilling from the 290 cross-cut. A new compressor, having a capacity of 1,350 cubic feet of air per minute, has been installed and is now in commission; this will enable more extensive development to be undertaken. A brief reference was made by the chairman at the shareholders' meeting to a matter of wider interest, namely, the new departure of selling the company's output of tin concentrate by private contract. This change he stated to have resulted in securing £10 per ton more than had been secured at the Tin Ticketing (or on the basis of last year's output close on £5,500 per annum), and the change was made because the directors were of the opinion "that the smelters took advantage" of the company. It is a matter of satisfaction to note this confirmation of the view consistently expressed in this Magazine for many years past.

Operations at the Castle-an-Dinas wolfram property owned by the company were restricted owing to the unremunerative price of wolfram. During the year 3,349 tons of ore was treated, from which 41½ tons of wolfram was recovered, or an average of 27·72 lb. per ton. The development carried out equalled 786 ft., and Mr. Paull estimated the average wolfram content for the distance driven to be 25 lb. per ton for a width of 3 ft.

CALLOOSE.—Our criticism of this company's prospectus in the February issue of the Magazine was thought at the time by some to be a little harsh, but the statutory meeting of the company proved up to the hilt the justification of our attitude. It will be remembered that we specially drew attention to the fact that the voluminous reports issued by the company were all made by interested officials, and that no actual data were given to justify the estimates of ore reserves and values given. The first sign of trouble was the decision in March to concentrate on the alluvial part of the proposition, and this in spite of the stated reserve of 600,000 tons of 22 lb. (tin) ore above adit in the Trevascus property, and also the large bodies of rich ore exposed on the Unity lode in the Wheal Hope section, averaging 60 lb. per ton, and on the Red lode in the Fraddam section averaging 55 lb. per ton. This early change of policy looked suspiciously suggestive. Then followed the offering of 16 tons of tin concentrate for sale at the Tin Ticketing, the sale of which never actually materialized. Obviously this caused the directors furiously to think, and the result was a hurried visit to the property and the dismissal of the general manager and staff and practically a suspension of operations. At the statutory meeting on April 20, the chairman admitted that the statement issued to the shareholders as to the sale of 16 tons of concentrate was not justified and asserted that the directors had been misled by the officials. In view of this and to ascertain "whether there had been misrepresentation in other directions and in particular with regard to the extent, value, and workability of the alluvial," an inspection was made by two engineers, Messrs. J. Daniel and W. W. Richardson, who, it is stated, are satisfied that "our alluvials are virgin deposits and that, under certain conditions, they can be most profitably worked." This is vague and elastic enough in all conscience, and while it appears that Mr.

Daniel merely expresses the opinion "that the whole valley for a length of $3\frac{1}{2}$ miles is tin-bearing virgin alluvium," Mr. Richardson, who spent three days on the properties, estimates that "there are at least 125 acres of tin-bearing alluvium, which at a minimum depth of $7\frac{1}{2}$ ft. will give one and a half million cubic yards of gravel," while he considers that the contour of the locality indicates a depth of double the figure named. It is clear from this that Mr. Richardson's opinion is not based on any systematic testing of the deposit; indeed, in view of the shortness of his visit, it obviously could not be.

One regrettable feature of this business is the association of instructors of the Camborne School of Mines with the company, and the use made by the promoter of the fact. From personal knowledge we know that people were largely influenced to take up shares on this ground alone. We feel bound to express the opinion that instructors at the School of Mines should either not be permitted to take up private work, or that their connection with the School should not be allowed to be advertised when reports are so made in their private capacity, as presumably was the case on this occasion.

TOLGUS MINES.—Some noteworthy footage figures are being secured in the tunnel which is being driven from the Agar shaft of the East Pool & Agar Company towards the Tolgus sett with a view to testing the Rogers and other lodes in that property below the old copper workings. This tunnel measures 10 by 8 ft. and is being driven with four Holman drills side by side, the men working continuously on six-hour shifts. The ground being driven in is granite, and the progress made last month (4 weeks) was 220 ft., which is surely an easy record for Cornwall in similarly hard ground. When the ground in the end is blasted, it falls on to a steel net, to which is subsequently attached a steel rope connected with a winch. In this way, the broken ground is speedily got away some little distance from the face, and thus the next shift can start work without the usual delay. A double tramroad has been installed and at present all the ground is being dumped into abandoned stopes. A smith's shop and a rock-drill repair shop have been fitted up underground, and thus time is saved on drill-sharpening and repair work. Captain Taylor is to be complimented on a well-thought-out scheme, and the men concerned for the vim and interest they are putting into the work.

LEVANT.—The shareholders in Geevor are now being invited to subscribe £45,000 of the £60,000 which was guaranteed by the Geevor Tin Mines, Limited, under the scheme referred to in the January issue. The shares are being issued at par and in the proportion of one for every four shares held in Geevor. The doubtless unavoidable delay over this matter now necessitates this issue at a time when tin-mining in Cornwall, or indeed mining speculation of any kind, is not too attractive, but we hope the money will be forthcoming without encroachment on the Geevor reserve capital, which will doubtless be needed for the enlarged operations of that concern. Levant has a fine record, as the recent article in the Magazine by Major F. Freethy Oats clearly showed, and given adequate capital, enlightened management, and a minimum price for tin metal of £300 per ton, there is every reason to anticipate satisfactory results in the future.

GRENVILLE.—The report for the three months ended March 31 last shows that 9,556 tons of ore was milled, from which was secured a return of 101 tons of black tin, or a recovery of 23·77 lb. per ton. This quantity realized £22,799 or £224. 16s. 6d. per ton. The development was 579 ft., which is a great improvement in this respect on the record of the old company. The water is now standing just below the 180 fm. level, and it is evident from the fact that all material possible was removed that there is no early intention of tackling the deeper levels. This policy will obviously effect a considerable reduction in the pumping charges. Vigorous exploratory work in the upper levels has resulted in a new lode being located in a cross-cut from Pease's shaft at the 90 fm. level, its value being 24 lb. of black tin over 2 ft. This cannot be payable under present conditions, but, on development, improved values may be met with. It is obvious from the report that Grenville is now being worked on sound lines.

GEEVOR.—Improved ventilation of the underground workings has been the result of the connection, long projected, but recently made, between the Geevor and Wheal Carne sections, while too this work has made available large reserves of payable ore. For the twelve weeks ended March 24 last, 7,717 tons of ore was milled which yielded 94 tons of black tin (wet weight), or a recovery of 27 lb. per ton. This is much below the past average of Geevor ore, but doubtless the management find it difficult to keep up the grade on the largely increased scale of operations. If, however, the reduced grade of ore is offset by an equivalent lower operating cost, the net financial result per ton handled will be the same. Recently a new lode north but parallel with the Pig lode has been located at the fifth and sixth levels, and, as the result of a considerable amount of drivage, the manager reports that its width and value is somewhat higher than the average of the other lodes on the property. As this lode is probably standing to surface, this is regarded as a very hopeful discovery.

DERBYSHIRE.

MILL CLOSE.—Reference was made in the January number of the Magazine to the position at this mine, where the paralysing effect of Labour Union domination (in this case the Derbyshire Miners' Union, affiliated to the Miners' Federation), and its influence in reducing efficiency, at last forced the owners to make a stand and resist the latest demand, put forward in July, 1919. This was in connection with a proposed reduction in the working force underground to meet low prices, and the claim was that, instead of the employers deciding which men were to be laid off, in which case they would naturally select the least efficient, the Union should select by ballot or otherwise, and in particular that two non-union men should be laid off before a single union man was touched. On the owners refusing to give way, the men all walked out.

After a fortnight's work with a nucleus force of only 11 loyal men, including shift-bosses, discharged soldiers, utterly ignorant of mining but willing to learn, were taken on and trained by the few skilled men available. By November an underground force of 27 men had been thus built up, 16 of whom were discharged soldiers, whose efficiency after only 6 to 8 weeks' training was higher than that of the skilled union miner.

In April, 1920, the mine, dressing, and smelting works were in full operation on a non-union basis, and on three shifts. With the exception of two development pitches, which have not been re-started, work underground is quite normal, with a working force of only 47 men against 85 before the strike. The output both of crude ore and of final product is greater than it was before the strike, although the working force is so much smaller, the tonnage per man in ore-getting and tramming being 30% to 35% higher than formerly. Under Trades Union domination the contract system had been rendered a farce by the introduction of a minimum wage, fixed so high as to do away with the incentive to increased exertion. Contracts have therefore been abandoned for the present, and all work is now upon day's pay, men being classified according to their ability to produce, the minimum being in all cases higher than the former minimum wage recognized by the Union. The pick of the men who went on strike have dropped their Union and have applied individually for readmittance, but for the majority of the remainder there are no vacancies, their places having been filled. A pleasing feature of the new regime is the cheerful and enthusiastic spirit now reigning underground, every man now endeavouring to do his best; the contrast with the sullen slacking of the period before the strike is most noticeable.

LETTER TO THE EDITOR

"A Contribution to the Study of Flotation."

The Editor:

Sir— I thank you for your Editorial Note in the April number of the Magazine relative to the attacks made upon me in the columns of certain technical journals in the United States, attacks which call in question my professional integrity and personal good faith.

I refer particularly to the recent articles in Mr. T. A. Rickard's paper, the *Mining and Scientific Press*, and to the anonymous attack of "An Occasional Contributor" which appeared in *Chemical and Metallurgical Engineering* for March 3. As regards the latter, it appears strange to one on this side of the Atlantic that the editor of a prominent technical publication should associate himself, by an editorial in the *same issue*, with allegations anonymously made, without awaiting the formality of a reply from the one assailed or affording opportunity for refutation. Happily one knows that such misuse of journalistic advantages is uncommon, and believes it to be deprecated in the States as it would be here.

Averse as I am from being drawn into a discussion of this nature, the publicity given to these attacks necessitates a reply, for the reason that having received many expressions of confidence from those whose opinion I value, it is only fair to them that I should justify my position; also because some readers of the articles referred to might construe continued silence on my part as a tacit admission of the validity of allegations which are mere moonshine, apparently not unmixed with malice. I gladly avail myself of your space for the purpose, not feeling inclined to refute these matters in columns where accusation and censure are simultaneous, and both are baseless.

As is well known I am co-patentee of a flotation process, the rights of which in the United States are owned by the Minerals Separation North American Corporation; this company has for years past been involved in patent suits with various American metallurgical interests, and in litigation which still follows the well-nigh interminable course which American law procedure permits. A small section of the American technical press apparently has motives for attacking the corporation, seemingly with the object of creating a volume of hostile opinion designed to have what effect it may upon the interests of the corporation in matters still awaiting final decision in the United States Courts.

In this campaign no stone is left unturned which might injure the corporation, and it is obvious that the paper read by me before the Institution of Mining and Metallurgy in November last has been regarded as offering the opportunity for a further move in the policy of discrediting the work of all who may be connected with the corporation.

I am accused of suppressing scientific information which, it is alleged, should have been published for the benefit of the industry years ago, and that this "presumably" existed in a typed booklet which I had then prepared for publication. The allegation is both untrue and futile.

I do not need to press the point that being retained, then as now, as consulting metallurgist to the British company (Minerals Separaton Ltd.) my employers have an unquestionable and determinative right to the results of any effort of mine, as to that of others of its staff; this must obviously be the case in every similar association, since, otherwise, professional ethics would be impossible. With regard, however, to my theories upon the subjects involved—whatever scientific value they may have—I would inquire by what law, ethical, legal, or sentimental, I am required to keep the world periodically informed in print of the progress of my views? I should be the best judge as to the time considered fit for their presentation and criticism.

Notwithstanding this, I will deal specifically with the facts in relation to the preparation by me of an earlier work on the subject, since in supporting the anonymous allegations as to "suppression," the editorial mentioned above conveys the insinuation "whether the paper now published contained the essential data which its author had presumably prepared for publication years ago."

In the discussion on my paper read before the Institution of Mining and Metallurgy, Sir Thomas Kirke Rose remarked that "he had heard that Mr. Sulman had written a book on the subject ten or twelve years ago, which had never been published, and that most of this paper was contained in it." This statement, and another reference to an unpublished book in the preface to Mr. T. J. Hoover's "Concentrating Ores by Flotation," is now used to create an atmosphere of mystery and suspicion with regard to my paper which is absolutely unjustified and in the interests of historical accuracy should be dispelled.

Soon after the invention of the Froth-Flotation process I devoted considerable attention to the theoretical explanation of the phenomena. In a paper by the late Prof. A. K. Huntington ("The Concentration of Metalliferous Sulphides by Flotation," December 1905) the role played by contact-angles was outlined. In measuring those made between water and various minerals I found that for each substance the contact angle may vary through a definite range: this variation I termed the Hysteresis of the contact angle; this fact was later published in Bulletin No. 79 of the Institution of Mining and Metallurgy.

In endeavouring to account for this hysteresis I availed myself of the assumption, generally held at the time, that certain minerals had the power of fixing or condensing an air-film on their surfaces, which was conceived to play a part in their flotation, as modified by the hysteresis value. The collected data were embodied in my notes (which now took the form of a type-written brochure) with the intention to make this the basis of a publication subsequently; Mr. T. J. Hoover was an officer of Minerals Separation Ltd. at this period.

This was the "book" referred to, and the views I tentatively expressed therein found their way into Mr. Hoover's subsequent volume on flotation, published in 1911 (see page 57).

Meanwhile it appeared that other discoveries in various fields of research might have a bearing on the explanation of flotation, and at my suggestion Mr. Emil Hatschek was commissioned by Minerals Separation Ltd. to report on the relation between flotation and the phenomena of colloid chemistry. As the volume of evidence at my disposal increased many discrepancies appeared, and it became certain that the subject was surrounded with yet further intricacies. Since I was anxious in the interests of Minerals Separation, no less than in my own, to avoid the publication of immature and questionable opinions, Professor C. V. Boys was consulted in 1914 and the evidence I had collected was placed at his disposal. Being too busy to undertake a lengthy investigation he considered the data submitted with Professor

Edser, coming to the conclusion that a further considerable amount of mathematical and experimental work would be necessary to arrive at a trustworthy theory. Accordingly Professor Edser carried out lengthy experimental work in our laboratory, with the result that the air-film hypothesis was definitely disproved, and the publication of the booklet I had compiled on the basis of former theories was therefore out of the question. With the invaluable assistance and advice of Professor Edser I recommenced the study of the subject from another aspect.

When it is recollected that a vast array of the phenomena theoretically involved had in many instances received but limited attention from physicists and chemists, and required close consideration in the scanty leisure of a consulting metallurgist who had also military duties to perform, I conceive that the delay in the publication of my views calls for no apology, and that accusations as to "suppression" of information which was not fully available till within a few months of the writing of the paper are excusable only on the ground of ignorance of the facts.

On the other hand I might, even now, be censured for undue precipitancy, and with some justice, as is indicated by the discussion on my paper.

For my views as published I accept full responsibility, and am quite prepared for criticism; but I am surely entitled to the time necessary to review, test, and remodel conclusions to be offered to the technical public, especially when this may include some whose interests induce them to disparage the conclusions arrived at.

In this connection I may contrast the charge of suppression with criticisms in the *Mining and Scientific Press* as to the "belated" value of my paper, that the matter in it was mainly known already and published by others, that it is "slovenly" in presentment, and so on. If this be so, why all the pother as to the detriment to the industry from delay in its publication? The complaint can scarcely hold in both directions.

Criticism is also urged as to my lack of reference to the work of others. This I dealt with in the discussion of Mr. Broadbridge's paper at the January meeting of the Institution of Mining and Metallurgy, in the following words: "Firstly, in many instances, he (Mr. Sulman) was expressing views of his own for which he could not predicate a wide or ready acceptance on the part of other metallurgists, and considered he had better bear the weight of his opinions, so far as he could, upon his own shoulders; secondly, he felt that personal references to technical services in a purely theoretical paper might well have been regarded as seeking to apportion credit or award praise, when nothing could be further from him than the knowledge, ability, right, or desire to express any such opinions."

As to the allegation that my partner, Mr. Hugh K. Pickard, found it "impossible . . . to appear as co-author of the paper," he authorizes me to state that this is correct, for the simple reason that he had no part in its preparation nor in the research which led to its publication. Neither was he co-author with me of the original notes referred to, for the sufficient fact of his absence from England during a large part of the time that the research was being conducted. It is true that during part of this time I had the benefit of his help, but he disclaims entirely co-authorship of the notes.

The twaddle as to "Mammon" and the suggestion that "as a large shareholder" I may influence the North American Corporation, although unworthy of notice, it may be well to dispose of once for all. The facts, that my holding in this corporation has never amounted to one-tenth per cent, that I was never an officer of the Corporation, nor in receipt from it of any fees, sufficiently refute such nonsense.

It must not, however, be inferred from this that I do not agree with all which those in its control have thought proper to do. I am simply not in a position to judge; but since I have been privileged to know them I am confident that in their actions, integrity, and honourable dealing, they have nothing to fear from their detractors.

Neither the North American Corporation nor Minerals Separation Ltd. has exercised initiative or restraint in the presentment or technics of my paper; the only censorship exercised was at my own request, when, as is usual and proper, I wished to make sure from Minerals Separation that nothing I might urge could influence matters still immature or unfinished.

My apologies are due to you, Sir, and to your readers for burdening you with this somewhat lengthly personal letter, and I thank the Magazine for giving me this opportunity for ventilating a subject to which I do not need to recur.

H. LIVINGSTONE SULMAN.

London, April 26.

[We refer to this letter elsewhere in this issue.—EDITOR.]

PERSONAL

A. H. AITKEN has gone to Northern Nigeria.

DR. J. H. ANDREW has been appointed professor of metallurgy in the Royal Technical College, Glasgow.

H. FOSTER BAIN is engaged in geological examinations in Yunnan, South China.

S. C. BATE is on a visit to New York and Quebec.

H. C. BOYD is here from the Rand.

PROFESSOR R. W. CHAPMAN has been elected president of the Australian Institute of Mining and Metallurgy.

HENRY CLARK has gone to the United States on a short visit for Head, Wrightson & Co., Ltd.

THOMAS A. CLARKE is on holiday from Egypt.

H. F. COLLINS has returned from Spain.

W. R. DEGENHARDT, chief engineer for the Burma Corporation, left for Burma an April 29.

H. S. DENNY has gone to Canada.

B. J. GILLARD has gone to Nigeria.

H. HANNAY has left for the Kepong mine, Selangor, Federated Malay States.

E. C. HARDER has resigned from the United States Geological Survey and is now in Philadelphia.

HAROLD HILL has returned from East Africa.

H. F. HUESTON is home from Nigeria.

J. M. ILES has returned from a visit to Australia.

CHARLES JANIN has gone from San Francisco to the Malay Peninsula. His address is c/o United States Consul, Penang.

H. A. G. JEFFREYS has been appointed secretary of the Chemical, Metallurgical, & Mining Society of South Africa.

R. L. LLOYD, of the Dwight & Lloyd Metallurgical Co., is on a visit to England and the Continent.

DR. MALCOLM MACLAREN has gone to Asia Minor.

ROBERT McLAREN has been re-elected president of the Mining Institute of Scotland for another year.

HUGH F. MARRIOTT has been appointed by the Privy Council a governor of the Imperial Mineral Resources Bureau.

CAPTAIN A. H. MOREING, M.P., has been appointed parliamentary private secretary to Sir Eric Geddes, Minister of Transport.

H. E. NICHOLLS has returned from Nigeria.

C. T. NICOLSON, London manager for the Bucyrus Company, was married on May 10 to Miss Margaret Lancaster Sharpe.

A. LIVINGSTONE OKE has gone to Panama.

J. SCOTT PARK is here on furlough from Nigeria.

A. J. PETERSON has returned from East Africa.

WALLINGTON A. POPE has gone to Northern Nigeria for Bainbridge, Seymour & Co.

FRANK RALEIGH is here from Johannesburg.

ALBERT REIS has resigned as mining engineer to the Huelva Copper & Sulphur Co., Spain, and is returning to England.

G. GORDON THOMAS has been elected a member of the Local Council in Nigeria of the Institution of Mining & Metallurgy.

A. G. B. WILBRAHAM has returned from Spain and is now on his way to the Malay Peninsula.

GERARD W. WILLIAMS is here from Nigeria.

CHARLES WILL WRIGHT left for New York on May 8.

A. K. HUNTINGTON died on April 17. He became an A.R.S.M. in 1877. From 1879 to 1919 he held the position of professor of metallurgy in King's College, London. He was one of the early presidents of the Institution of Mining and Metallurgy, and more recently he was president of the Institute of Metals. He was an influential member of the Iron and Steel Institute, the Institute of Chemistry, the Society of Chemical Industry, and the Faraday Society. His favourite hobby was aeronautics, and he was a noted scientific balloonist in days gone by.

S. HERBERT COX died on April 11. In 1872, he went to the Royal School of Mines, where he took the associateship in 1874. In the latter year he went to New Zealand to take a position with the Geological Survey. From 1884 to 1890 he was instructor in geology, mineralogy, and mining at the Sydney Technical College. From 1891 to 1907 he was a partner in the firm of Bainbridge, Seymour & Co., in London. In 1905 he was appointed professor of mining in the Royal School of Mines, a position which he resigned in 1912 owing to failing health. He served as president of the Institution of Mining and Metallurgy in 1900. His book "Prospecting for Minerals" is well known to students.

TRADE PARAGRAPHS

T. COOKE & SONS, LTD., of York, send us their pamphlet No. 520, which gives full particulars of the surveyor's levels on the Zeiss pattern now made by them.

THE WORTHINGTON PUMP AND MACHINERY CORPORATION, of 115, Broadway, New York, send us catalogues 530 B and 531 B dealing with their Laidlaw feather-valve air-compressors.

GEORGE F. WEST & CO., of Iddesleigh House, Westminster, send us a pamphlet describing the dredges, steam-shovels, drag-line excavators, etc., made by the Bucyrus Company and the Western Wheeled Scraper Company.

THE STURTEVANT ENGINEERING CO., LTD., of 147, Queen Victoria Street, London, E.C.4, send us new editions of their catalogues No. 1,014 and No. 1,052, describing respectively their Monogram blowing and exhausting fans and their steel-plate fans.

THE CONSOLIDATED PNEUMATIC TOOL CO., LTD., of 170, Piccadilly, London, W.1, send us a number of catalogues relating to rock-drills and air-compressors. This firm are agents for the Hummer rock-drills, made by the Chicago Pneumatic Tool Company, particulars of which are given in Bulletin 399. A description of the Hummer drill was given in the Magazine for August last in Mr. David Penman's article on rock-drill practice.

HOLMAN drills have broken the record for shaft-sinking once more. At the New State Areas mine the Southern shaft was sunk 270 ft. in a month and the North shaft 245 ft. At West Springs 244 ft. was sunk. These shafts are all rectangular and the previous record for such a shaft was 235 ft. The Holman cradle hammer-drill has done good work at Geduld, three machines in 26 shifts breaking 176 fathoms, being at the rate of 2¼ fathoms per machine shift.

METAL MARKETS

COPPER.—The market on this side of the Atlantic has had rather a fluctuating tendency during the month of April, although the extreme prices were within a comparatively narrow range. The general tendency has been for copper to move according to the variations in the rate of exchange with America. When the exchange dropped, copper rose, and vice versa. With the consuming trades, business has not been particularly active in new copper. Certainly the bulk of the trade seems to have been done with the wire-drawing industry, and it looks as though the brass-founding trade were finding it practicable to get along largely on

DAILY LONDON METAL PRICES: OFFICIAL CLOSING
Copper, Lead, Zinc, and Tin per Long

	COPPER				
	Standard Cash	Standard (3 mos.)	Electrolytic Ingots	Electrolytic Wire-Bars	Best Selected
April	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
12	102 10 0 to 102 15 0	105 2 6 to 105 7 6	111 0 0 to 113 0 0	111 0 0 to 113 0 0	110 0 0 to 112 0 0
13	104 0 0 to 104 5 0	106 10 0 to 106 15 0	112 0 0 to 115 0 0	112 0 0 to 115 0 0	111 0 0 to 113 0 0
14	104 10 0 to 104 15 0	107 0 0 to 107 5 0	112 0 0 to 115 0 0	112 0 0 to 115 0 0	111 0 0 to 113 0 0
15	103 10 0 to 103 15 0	106 5 0 to 106 10 0	112 0 0 to 115 0 0	112 0 0 to 115 0 0	111 0 0 to 113 0 0
16	102 15 0 to 103 0 0	105 10 0 to 105 15 0	111 0 0 to 114 0 0	111 0 0 to 114 0 0	110 0 0 to 112 0 0
19	102 10 0 to 102 15 0	105 10 0 to 105 15 0	110 0 0 to 113 0 0	110 0 0 to 113 0 0	110 0 0 to 112 0 0
20	102 0 0 to 102 5 0	105 0 0 to 105 5 0	110 0 0 to 112 0 0	110 0 0 to 112 0 0	109 0 0 to 111 0 0
21	100 5 0 to 100 10 0	103 5 0 to 103 10 0	110 0 0 to 112 0 0	110 0 0 to 112 0 0	109 0 0 to 111 0 0
22	100 10 0 to 103 15 0	103 5 0 to 103 10 0	110 0 0 to 112 0 0	110 0 0 to 112 0 0	109 0 0 to 111 0 0
23	101 10 0 to 101 15 0	104 5 0 to 104 10 0	110 0 0 to 113 0 0	110 0 0 to 113 0 0	109 0 0 to 111 0 0
26	103 5 0 to 103 10 0	105 15 0 to 106 0 0	111 0 0 to 113 0 0	111 0 0 to 113 0 0	109 0 0 to 111 0 0
27	105 0 0 to 105 2 6	107 10 0 to 107 15 0	112 0 0 to 115 0 0	112 0 0 to 115 0 0	111 0 0 to 112 0 0
28	103 0 0 to 103 5 6	105 15 0 to 106 0 0	112 0 0 to 114 0 0	112 0 0 to 114 0 0	111 0 0 to 112 0 0
29	101 15 0 to 104 0 0	104 5 0 to 111 0 0	111 0 0 to 113 0 0	111 0 0 to 113 0 0	111 0 0 to 112 0 0
30	101 15 0 to 102 0 0	104 5 0 to 104 10 0	111 0 0 to 113 0 0	111 0 0 to 113 0 0	111 0 0 to 112 0 0
May					
3	102 0 0 to 102 5 0	104 15 0 to 105 0 0	111 0 0 to 114 0 0	111 0 0 to 114 0 0	111 0 0 to 112 0 0
4	101 10 0 to 101 15 0	104 0 0 to 104 5 0	111 0 0 to 114 0 0	111 0 0 to 114 0 0	111 0 0 to 112 0 0
5	101 5 0 to 101 10 0	103 15 0 to 104 0 0	111 0 0 to 114 0 0	111 0 0 to 114 0 0	111 0 0 to 112 0 0
6	100 15 0 to 101 0 0	103 10 0 to 103 15 0	111 0 0 to 114 0 0	111 0 0 to 114 0 0	111 0 0 to 112 0 0
7	101 0 0 to 101 5 0	103 15 0 to 104 0 0	112 0 0 to 114 0 0	112 0 0 to 114 0 0	111 0 0 to 112 0 0
10	101 10 0 to 101 15 0	104 5 0 to 104 10 0	112 0 0 to 114 0 0	112 0 0 to 114 0 0	111 0 0 to 112 0 0
11	101 5 0 to 101 10 0	103 15 0 to 104 0 0	112 0 0 to 114 0 0	112 0 0 to 114 0 0	111 0 0 to 112 0 0

scrap material. This factor, that is to say, the supplies of scrap, has really been exerting a considerable influence on the copper situation practically ever since the end of the war. The big producers did not seem to foresee what an influence on the situation the surplus scrap metal, which was left over when the war ended, would have upon the situation, but they are no doubt now beginning to realize it. Trade with the Continental countries has been largely retarded by the adverse rates of exchange which have been ruling, although latterly some business has been done with Germany in spite of the adverse conditions they have to meet. In America the market has been somewhat overshadowed by the railway strike there and conditions have been dull. At one time the prospects of increased shipments to Europe, as a result of the credits it was proposed to grant, created a firmer feeling which was accentuated by some optimistic statements in regard to the general statistical position of the metal. This firmness, however, seems to have evaporated on the realization that there was plenty of metal to meet both domestic and foreign requirements. Latterly the financial crisis in Japan was the cause of that country offering to resell some of the metal previously purchased, though it is doubtful whether much business has been done.

Average prices of cash standard copper: April 1920, £103. 2s. 11d.; March 1920, £109. 11s. 11d.; April 1919, £77. 7s.; March 1919, £76. 17s. 7d.

TIN.—This market, as usual, fluctuated somewhat during the month of April. At one time considerable selling pressure was seen, and at the lower level of prices which was thus established buyers in America showed a distinct disposition to pick up tin, but they did not seem much inclined to follow the subsequent improvement in prices. In addition the railway trouble which has prevailed there has not been conducive to much buying, although purchases are also understood to have been made in the East by United States interests. At home, business with the consuming trade has been spasmodic, but the amount of metal going into consumption must be considerable when the activity of the tinplate works is considered. Owing to the heavy selling of forward metal and the fact that spot stocks appeared to be to some extent set aside for shipment to America, cash, or prompt tin, went to a premium, which proved to be only a temporary factor, however, At one time some selling was done in the standard market against the holdings of Chinese tin in the East, this apparently having been brought about by the financial crisis in Japan. It is believed to be probable that the stocks here will be augmented at an early date by arrivals of Chinese tin, but this selling was not continued to any important extent. Early in May, however, some further active selling was in evidence, this coming from the same quarters which have hitherto been credited with dealings against holdings of Dutch tin. This considerably depressed prices, while the arrival of about 2,000 tons of Banka tin at Swansea from Holland also assisted the market in a downward direction, so that the market reflected a drop of fully £100 per ton from the high level touched a few months ago.

Average prices of cash standard tin: April 1920, £345. 13s. 1d.; March 1920, £369. 14s. 5d.; April 1919, £225. 6s. 6d.; March 1919, £236. 18s. 5d.

LEAD.—This market tended easier in the early part of the month owing to a general tendency on the part of holders to liquidate, which seems to have been caused by the fairly large quantities of prompt metal which were available. A further factor, however, tending toward easier conditions was the published cable from Melbourne to the effect that the Victorian Trades and Labour Council had arranged a conference with a view to settling the strike at Broken Hill. This conference resulted in a offer being made by the companies to the miners, which, however, was rejected, and so far no settlement has been arrived at. The market was naturally influenced by the various reports which came to hand, although it was recognized that even if work were resumed immediately the new output could not be available for many months to come. Later the market took on rather a firmer tone, which was the means of bringing out a fair number of orders from consumers who no doubt were covering themselves against manufactured material already sold. Business as a whole, however, with the consuming trades has not been very active, and export inquiry has also been quiet. The latter indeed looks as if it would continue so unless the rates of exchange with the Continent im-

PRICES ON THE LONDON METAL EXCHANGE.
Tons; Silver per Standard Ounce; Gold per Fine Ounce.

Lead: Soft Foreign (£ s. d. to £ s. d.)	Lead: English (£ s. d.)	Zinc (Spelter) (£ s. d. to £ s. d.)	Standard Tin: Cash (£ s. d. to £ s. d.)	Standard Tin: 3 mos. (£ s. d. to £ s. d.)	Silver: Cash	Silver: Forward	Gold (s. d.)	April
37 15 0 to 40 15 0	42 0 0	48 0 0 to 50 15 0	345 0 0 to 345 5 0	345 5 0 to 345 10 0	[illegible]	[illegible]	[illegible] 5	12
38 10 0 to 41 5 0	42 0 0	49 5 0 to 51 10 0	346 0 0 to 346 10 0	346 0 0 to 346 10 0	[illegible]	[illegible]	[illegible]	13
39 0 0 to 41 12 6	42 10 0	48 15 0 to 51 10 0	350 0 0 to 350 10 0	349 10 0 to 350 0 0	[illegible]	[illegible]	[illegible]	14
38 10 0 to 41 5 0	42 0 0	48 5 0 to 50 15 0	346 0 0 to 346 10 0	344 10 0 to 345 0 0	68	66¼	103 7	15
37 15 0 to 40 5 0	41 0 0	47 10 0 to 49 15 0	343 0 0 to 343 10 0	341 10 0 to 342 0 0	[illegible]	[illegible]	103 7	16
37 15 0 to 38 17 6	40 0 0	46 10 0 to 48 15 0	350 0 0 to 350 10 0	348 0 0 to 348 10 0	68½	65⅞	[illegible] 0	19
37 5 0 to 39 0 0	40 0 0	45 15 0 to 47 5 0	349 10 0 to 350 0 0	347 10 0 to 348 0 0	[illegible]	66	[illegible]	20
38 5 0 to 39 15 0	40 10 0	45 5 0 to 46 17 6	344 10 0 to 345 0 0	342 15 0 to 343 0 0	[illegible]	67¼	104 [illegible]	21
39 15 0 to 41 10 0	42 10 0	45 10 0 to 47 5 0	346 0 0 to 346 10 0	[illegible] 10 0 to [illegible] 0 0	[illegible]	[illegible]	106 0	22
40 5 0 to 41 15 0	42 10 0	46 10 0 to 48 2 6	346 10 0 to 347 0 0	343 15 0 to 344 5 0	69½	[illegible]	106 9	[illegible]
40 10 0 to 41 10 0	42 10 0	49 0 0 to 50 5 0	346 15 0 to 347 5 0	345 0 0 to 346 15 0	[illegible]	67¼	107 6	26
41 10 0 to 42 15 0	43 10 0	49 5 0 to 51 0 0	347 15 0 to 348 0 0	347 0 0 to 347 5 0	65	64	109 0	27
41 10 0 to 42 10 0	43 10 0	47 15 0 to 49 10 0	347 5 0 to 347 10 0	346 5 0 to 346 10 0	66½	64½	108 4	28
41 0 0 to 42 5 0	43 0 0	47 0 0 to 48 5 0	345 10 0 to 346 0 0	344 15 0 to 345 0 0	66	64½	106 6	[illegible]
40 0 0 to 41 5 0	42 0 0	46 15 0 to 48 10 0	345 0 0 to 345 10 0	344 5 0 to 344 15 0	64½	63	107 6	30
								May
40 0 0 to 41 10 0	42 0 0	46 15 0 to 48 10 0	345 0 0 to 345 10 0	344 10 0 to 344 15 0	65½	64	108 0	3
40 0 0 to 41 10 0	42 0 0	46 5 0 to 48 0 0	342 10 0 to 342 15 0	342 5 0 to 342 10 0	64¾	62⅞	107 0	4
39 5 0 to 40 17 6	41 10 0	46 0 0 to 47 15 0	323 10 0 to 324 0 0	324 10 0 to 325 0 0	63¼	62	107 6	5
37 15 0 to 39 5 0	40 0 0	46 10 0 to 48 0 0	307 0 0 to 308 0 0	309 0 0 to 310 0 0	62½	60⅝	108 3	6
36 0 0 to 37 5 0	39 0 0	46 5 0 to 48 0 0	314 0 0 to 314 10 0	317 10 0 to 318 0 0	60	59¼	108 0	7
37 15 0 to 39 0 0	40 0 0	46 5 0 to 48 5 0	304 0 0 to 304 10 0	306 10 0 to 307 0 0	61½	60	107 6	10
38 0 0 to 39 5 0	40 0 0	45 15 0 to 47 10 0	299 0 0 to 300 0 0	301 10 0 to 302 0 0	60	58½	108 0	11

prove, while further sales to Japan can hardly be expected to be made in present circumstances. Early in May, further realizations again caused a considerable amount of weakness in the market,

Average prices of soft pig lead: April 1920, £40. 4s.; March 1920, £47. 1s. 10d.; April 1919, £24. 8s. 7d.; March 1919, £26. 16s. 11d.

SPELTER.—This market has fluctuated somewhat during the period under review. At one time it was affected by the general desire to liquidate speculative holdings and no doubt the position is now all the healthier for the realizing which has taken place. At the lower level consumers showed some disposition to pick up metal and the market improved, assisted by the fact that the exchange rate with America became more adverse for this country. The situation generally continues to be rather uncertain. While no doubt a good deal of the prompt metal which was hanging around the market has been disposed of, there still seems to be much more to come forward from America. The market in that country has been easier also, no doubt largely as a result of the easier conditions here, and prices in that quarter fell considerably during the month of April. As a matter of fact producers there seem to have increased output, depending on a demand from here. This demand has not come along, and as a consequence, prices had to give way. While the domestic consumption in America is believed to be quite good, it is apparently insufficient to use up the output. Meanwhile prices have dropped below the cost of production in this country, and for that reason it might be expected that prices should not fall much further. On the other hand it appears that some of the Belgian works are now prepared to sell to this country, and this may have a weakening influence here.

Average price of spelter: April 1920, £48. 9s. 4d.; March 1920, £54. 16s. 8d.; April 1919, £35. 18s. 3d.; March 1919, £37. 10s. 3d.

ZINC DUST.—Prices have remained steady at about £85 per ton for high-grade Australian material.

ANTIMONY.—English regulus has continued steady at £72 per ton, but it is understood that large lots can now be had at a shade less. Meanwhile foreign regulus has been easier as a result apparently of the financial crisis in Japan, which apparently forced some liquidations. Prices declined to about £55 per ton c.i.f for shipment from the East and to about £60 in warehouse here.

ARSENIC.—Featureless at £68 to £70 for white delivered London.

BISMUTH.—Steady business has been done at about 12s. 6d. per lb.

CADMIUM.—Good inquiry and fairly active business passing at 6s. 6d. to 6s. 9d. per lb.

ALUMINIUM.—Firm at £165 for home trade and £185 for export.

NICKEL.—£230 for home and export.

COBALT METAL.—14s. per lb.

COBALT OXIDE.—10s. per lb. (black).

PLATINUM.—Nominal £25 per oz.; market weak.

PALLADIUM.—Nominal, and business entirely subject to negotiation.

QUICKSILVER.—This market has been quiet and prices have tended easier. The spot stocks were replenished but inquiry was small. Re-sale lots have been on offer, and this weakened the quotation, which dropped to about £22 to £23 per bottle.

SELENIUM.—10s. to 11s. per lb.

TELLURIUM.—95s. to 100s. per lb.

SULPHATE OF COPPER.—Lower at about £45 to £46 per ton.

MANGANESE ORES.—Position very tight at 4s. 3d per unit c.i.f. U.K. for Indian grades. Supplies scarce and output fully sold. Prompt material almost unobtainable. Caucasian is offered but freight is scarce.

TUNGSTEN ORES.—34s. per unit for wolframite 65%; and 32s. 6d. per unit for scheelite 65%.

MOLYBDENITE.—100s. nominal per unit c.i.f. for Canadian 85%.

SILVER.—The market has generally tended lower. On April 1 the price of standard bars was 72½d. and at the end of the month was 64½d. Continental selling seemed to be the chief cause of the reaction.

GRAPHITE.—Steady and quiet at prices ranging from soft velvety flake 85% to 90% at £60 to £80 per ton c.i.f., to Madagascar 82% at £19 per ton c.i.f.

CHROME ORES.—(48–50%), £9. 5s. per ton c.i.f. U.K.

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Par Value
	Oz.	Oz.	Oz.	£
March, 1919	694,825	17,554	712,379	3,025,992
April	676,702	18,242	694,944	2,951,936
May	706,158	18,837	724,995	3,079,583
June	682,603	19,776	702,379	2,983,515
July	705,523	19,974	725,497	3,081,713
August	686,717	19,952	706,669	3,001,739
September	680,359	18,199	698,558	2,967,287
October	705,313	18,409	723,722	3,074,174
November	657,845	20,125	677,920	2,879,834
December	631,833	18,358	650,191	2,761,836
Year 1919	8,111,271	218,820	8,330,091	35,383,974
January 1920	653,295	17,208	670,503	*
February	607,918	17,412	625,330	*
March	689,645	17,391	707,036	*
April	667,926	19,053	686,979	

* Not given in the official returns.

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
March 31, 1919	175,620	11,168	5,080	191,868
April 30	175,267	11,906	5,742	192,915
May 31	173,376	12,232	5,939	191,547
June 30	172,505	12,544	5,831	190,880
July 31	173,613	12,453	5,736	191,802
August 31	170,844	12,450	5,655	188,949
September 30	169,120	12,392	5,294	186,806
October 31	167,499	12,691	4,492	184,682
November 30	164,671	12,565	4,337	181,573
December 31	166,155	12,750	4,271	183,176
January 31, 1920	176,390	12,766	4,796	193,952
February 29	185,185	12,708	5,217	203,110
March 31	188,564	12,788	5,232	206,584
April 30	189,446	12,951	5,057	207,454

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 65% of the working profit. Figures for yield and profit for 1919 based on par value of gold; subsequently gold premium included.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1918	24,922,763	27 11	21 7	6 0	7,678,129
January, 1919	1,942,329	28 9	23 0	5 8	547,793
February	1,816,352	28 9	23 2	5 6	498,204
March	2,082,469	28 2	22 6	5 6	573,582
April	1,993,652	28 7	22 9	5 9	573,143
May	2,099,450	28 4	22 3	5 10	608,715
June	2,032,169	28 4	22 4	5 10	592,361
July	2,134,668	27 10	21 9	6 0	611,118
August	2,036,128	28 5	22 11	5 5	551,203
September	2,019,109	28 6	22 10	5 7	560,979
October	2,108,698	28 3	22 6	5 10	612,841
November	1,933,526	28 8	23 5	5 5	521,472
December	1,845,088	28 8	25 6	3 10	354,098
Year 1919	24,043,638	28 7	22 11	5 6	6,605,509
January, 1920	2,038,092	34 4	24 2	10 2	1,036,859

Production of Gold in Rhodesia and West Africa.

	Rhodesia.		West Africa.	
	1919	1920	1918	1919
	£	oz.	£	£
January	211,917	43,428	107,863	104,063
February	220,885	44,237	112,865	112,616
March	225,808	45,779	112,605	112,543
April	213,160	—	117,520	109,570
May	218,057	—	126,290	100,827
June	214,215	—	120,273	106,612
July	214,919	—	117,581	102,467
August	207,339	—	120,526	103,112
September	223,719	—	115,152	100,401
October	204,184	—	61,461	91,352
November	186,462	—	108,796	98,322
December	158,835	—	112,621	98,806
Total	2,499,498	133,444	1,333,553	1,240,691

Transvaal Gold Outputs.

	February.		March.	
	Treated	Yield	Treated	Yield
	Tons	Oz.	Tons	Oz.
Aurora West	11,900	£15,466	14,000	£15,346
Brakpan	43,000	£80,463	52,300	£89,583
City & Suburban	12,600	£16,913	13,784	3,144
City Deep	47,500	19,567	62,500	25,317
Cons. Langlaagte	32,300	£53,426	46,500	£64,729
Cons. Main Reef	39,600	13,805	48,400	17,033
Crown Mines	170,000	51,494	202,000	59,290
Durban Roodepoort Deep	23,900	7,810	24,800	7,779
East Rand P.M.	106,000	29,827	124,000	33,389
Ferreira Deep	35,200	10,639	36,000	11,493
Geduld	42,000	15,172	45,000	15,990
Geldenhuis Deep	41,700	12,470	44,900	13,060
Glynn's Lydenburg	2,894	£5,540	3,465	£5,899
Goch	14,000	£13,335	19,700	£16,383
Government G.M. Areas	102,500	£231,088	129,500	£270,483
Heriot	10,670	£16,206	11,800	3,054
Jupiter	21,000	4,794	25,800	5,911
Kleinfontein	47,500	£73,317	48,260	14,100
Knights Central	21,800	6,860	26,250	7,819
Knights Deep	88,700	16,469	9,600	16,194
Langlaagte Estate	24,700	£41,505	42,000	59,240
Luipaard's Vlei	18,100	£20,729	21,230	£24,332
Meyer & Charlton	11,900	£43,151	13,030	£40,336
Modderfontein	36,400	42,338	96,000	46,206
Modderfontein B	43,500	21,260	52,500	23,396
Modderfontein Deep	39,600	21,436	43,900	23,512
New Unified	8,900	£13,760	11,000	£15,203
Nourse	34,700	12,637	43,800	15,106
Primrose	16,000	£18,795	19,000	£19,410
Princess Estate	16,400	4,367	20,400	5,372
Randfontein Central	127,500	£192,714	150,000	£213,737
Robinson	35,100	8,441	41,600	9,191
Robinson Deep	50,100	16,520	55,200	17,207
Roodepoort United	18,600	£22,829	22,200	£23,995
Rose Deep	49,600	12,490	58,600	14,680
Simmer & Jack	46,100	11,326	47,000	10,941
Simmer Deep	45,500	10,150	43,700	9,515
Springs	33,900	£59,757	41,000	£74,687
Sub Nigel	9,200	5,532	10,300	6,058
Transvaal G.M. Estates	15,760	£30,543	16,650	£30,992
Van Ryn	34,530	£45,926	37,450	£41,687
Van Ryn Deep	46,900	133,187	53,000	£149,019
Village Deep	33,500	11,352	47,800	13,823
Village Main Reef	17,400	4,687	18,400	5,106
West Rand Consolidated	25,730	£39,117	32,300	£43,874
Witwatersrand (Knights)	32,750	£48,154	39,500	£54,445
Witwatersrand Deep	30,200	10,100	34,300	10,971
Wolhuter	29,700	8,208	31,700	8,880

West African Gold Outputs.

	February.		March.	
	Treated	Value	Treated	Value
	Tons	Oz.	Tons	Oz.
Abbontiakoon	6,064	£10,940	7,736	£15,020
Abosso	7,210	2,886	7,200	2,881
Akoko	—	—	300	290
Ashanti Goldfields	2,413	3,438	1,864	2,004
Obbuassi	370	331	496	419
Prestea Block A	10,887	18,966	11,200	5,876
Taquah	4,705	2,879	4,750	2,882

Rhodesian Gold Outputs.

	February.		March.	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Falcon	14,026	22,513*	15,997	28,224
Gaika	3,134	5,044	3,460	5,301
Globe & Phœnix	5,637	5,991†	5,966	6,462†
London & Rhodesian	2,385	2,982	1,958	2,225
Lonely Reef	4,300	5,544†	4,580	5,876†
Rezende	5,500	2,350†	5,800	2,510†
Rhodesia, Ltd.	671	496	—	—
Rhodesia, G.M. & I.	559	440†	574	387†
Shamva	49,556	44,154	51,301	39,909
Transvaal & Rhodesian	1,700	4,374	1,700	4,290

* Gold, Silver and Copper; † Ounces Gold.

West Australian Gold Statistics.—Par Values.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
March, 1919	*nil*	66,158	66,158	281,120
April	33	63,465	63,498	269,720
May	525	68,655	69,180	293,856
June	1,050	73,546	74,596	316,862
July	680	68,028	68,708	292,852
August	835	58,117	58,952	250,410
September	†	†	†	†
October	586	64,987	65,573	278,535
November	1,171	64,823	65,994	280,323
December	831	27,334	28,165	162,575
January, 1920	836	25,670	26,506	112,590
February	1,928	49,453	51,381	218,251
March	*nil*	54,020	54,020	229,461
April	835	56,256	57,091	242,506

† Figures not received.

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1919	1920	1919	1920	1919	1920
	£	Oz.	£	Oz.	£	£
January	36,238	7,105	37,100	4,724	18,000	28,000
February	46,955		43,330	7,200	24,000	15,000
March	40,267		48,000	7,000	16,000	—
April	63,818		61,200	—	24,000	—
May	37,456	—	38,200	—	16,000	—
June	41,465	—	44,600		17,000	—
July	37,395	—	42,060		22,000	—
August	51,564	—	49,700		20,000	—
September	76,340	—	37,120	—	13,000	—
October	39,018	-	36,100		28,000	—
November	40,735	-	32,720	-	51,000	—
December	63,311	—	44,500	—	31,000	—
Total	575,260	7,105	514,630	18,924	280,000	43,000

Australasian Gold Outputs.

	February.		March.	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Associated	5,166	6,993	5,896	7,773
Associated Northern Blocks :				
Iron Duke	—	631*	—	—
Victorious	—	137*	—	—
Blackwater	2,413	4,071	2,550	4,309
Bullfinch	4,730	43,467	6,000	5,096
Golden Horseshoe	10,716	19,351	11,196	20,023
Great Boulder Prop.	9,474	27,577	10,928	31,663
Ivanhoe	14,218	5,400‖	15,169	5,400
Kalgurli	2,478	6,206	3,920	7,983
Lake View & Star	11,934	13,179A	8,873	10,982
Menzies Consolidated	1,560	3,111	1,710	3,527
Oroya Links	1,548	7,529†	1,902	9,822†
Progress	1,270	1,458	1,270	1,352
Sons of Gwalia	11,914	15,490	10,997	14,501
South Kalgurli	7,456	7,962	8,082	8,069
Waihi	13,669	4,020‡	13,742	4,278‡
Waihi Grand Junction	3,540	1,110‡	2,880	1,144‡

* Surplus ; † Total receipts ; ‡ Oz. ; ‖ Profit ;
A Nov. 1 to Feb. 29.

Miscellaneous Gold Outputs.—Par Values.

	February.		March.	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
El Oro (Mexico)	29,259	249,000†	31,000	238,000†
Esperanza (Mexico)	18,160	1,998§	19,541	1,772§
Frontino & Bolivia (C'lbia)	2,410	9,031	2,410	9,031
Mexico El Oro (Mexico)	11,800	222,640†	11,770	219,000†
Nechi (Colombia)	18,640*	6,464†	93,259*	14,346†
Oriental Cons. (Korea)	—	88,000†	—	116,000†
Ouro Preto (Brazil)	7,000	2,453‖	7,900	2,726
Pato (Colombia)	70,425*	36,462†	—	—
Plymouth Cons. (Calif'rnia)	8,700	11,316	8,600	11,681
St. John del Rey (Brazil)	—	39,000	—	36,000
Santa Gertrudis (Mexico)	26,950	39,750‡	31,360	37,640‡

* Cubic yards. § Loss † Dollars. ‡ Profit, gold and silver. ‖ Oz.

Production of Gold in India.

	1916	1917	1918	1919	1920
	oz.	oz.	oz.	oz.	oz.
January	45,214	44,718	41,420	[illegible]	[illegible]
February	43,121	42,566	40,787	36,854	[illegible]
March	43,702	44,011	41,719	38,317	38,760
April	44,797	43,788	41,504	38,248	37,307
May	45,055	[illegible]	40,889	38,608	—
June	44,842	42,924	41,264	38,359	—
July	45,146	42,273	40,229	38,549	—
August	45,361	42,591	40,496	37,850	—
September	45,255	43,207	40,088	36,813	—
October	45,061	43,041	39,472	37,138	—
November	45,247	42,915	36,984	39,628	—
December	48,276	44,883	[illegible]	42,643	—
Total	541,077	520,362	[illegible]	[illegible]	151,012

Indian Gold Outputs.

	March.		April.	
	Tons Treated	Fine Ounces	Tons Treated	Fine Ounces
Balaghat	3,200	2,201	3,150	2,200
Champion Reef	12,582	7,084	12,223	6,938
Hutti (Nizam's)	—	—	—	—
Mysore	20,852	14,483	20,168	13,048
North Anantapur	700	1,084	700	1,076
Nundydroog	8,708	6,306	8,527	6,34[illegible]
Ooregum	12,600	7,602	12,550	7,[illegible]

Base Metal Outputs.

		Feb.	March
Arizona Copper	Short tons copper	1,500	1,500
British Broken Hill	Tons lead conc.	—	—
	Tons zinc conc.	—	—
	Tons carbonate ore	—	—
Broken Hill Block 10	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Burma Corp.	Tons refined lead	1,810	2,181
	Oz. refined silver	226,720	[illegible]
Fremantle Trading	Long tons lead	—	
Hampden Cloncurry	Tons copper	585	156
North Broken Hill	Tons lead	—	—
	Oz. silver	—	—
Poderosa	Tons copper ore	529	—
Rhodesian Broken Hill	Tons lead	1,261	1,002
Tanganyika	Long tons copper	1,874	—
Tolima	Tons silver-lead conc.	45	[illegible]
Zinc Corp.	Tons zinc conc.	—	—
	Tons lead conc.	—	—

Imports of Ores, Metals, etc., into United Kingdom.

		March.	April
Iron Ore	Tons	640,592	748,418
Manganese Ore	Tons	34,177	[illegible]
Copper and Iron Pyrites	Tons	61,[illegible]	63,59[illegible]
Copper Ore, Matte, and Precipitate	Tons	2,517	[illegible]
Copper Metal	Tons	7,818	10,[illegible]
Tin Concentrate	Tons	2,419	[illegible]
Tin Metal	Tons	1,801	1,440
Lead, Pig and Sheet	Tons	13,600	10,4[illegible]6
Zinc (Spelter)	Tons	14,5[illegible]	10,[illegible]
Quicksilver	Lb.	50[illegible]	[illegible]
Zinc Oxide	Tons	385	[illegible]
White Lead	Cwt.	27,053	[illegible]
Barytes	Cwt.	41,191	[illegible]
Phosphate	Tons	27,312	66,976
Brimstone	Tons	1,340	[illegible]64
Borax	Cwt.	491	2,000
Other Boron Compounds	Tons	2,914	1,978
Nitrate of Soda	Cwt.	449,270	164,980
Nitrate of Potash	Cwt.	16,449	[illegible]
Petroleum :			
Crude	Gallons	95,902	[illegible]
Lamp Oils	Gallons	19,680,218	[illegible]
Motor Spirit	Gallons	20,216,4[illegible]	[illegible]
Lubricating Oils	Gallons	9,305,130	[illegible]
Gas Oil	Gallons	2,048,027	[illegible]
Fuel Oil	Gallons	12,102,956	13,[illegible],764
Total Petroleum	Gallons	63,448,065	[illegible]2,761

United States Metal Exports and Imports.

Exports.	Oct. Tons.	Nov. Tons.	Imports.	Oct. Tons.	Nov. Tons.
Copper Ingots	19,643	12,802	Antimony	1,083	251
Copper Tubes	350	197	Tin Con.	2,366	1,172
Copper Sheets	311	203	Tin	7,237	6,800
Copper Wire	1,835	1,464	Manganese Ore	15,863	11,694
Lead, Pig	3,721	2,511	TungstenCon	592	1,423
Zinc	9,650	5,009	Pyrites	67,155	40,259
Zinc Sheets	1,231	1,063			

Outputs of Tin Mining Companies.

In Tons of Concentrate.

	Jan. Tons	Feb. Tons	March Tons
Nigeria:			
Associated Nigerian	20	–	20
Benue	4	4	4½
Bisichi	14	7	12
Bongwelli	3	4½	–
Dua	5	4⅛	3¼
Ex-Lands	30	30	30
Filani	3¼	3¼	–
Forum River	11	9	9
Gold Coast Consolidated	2	2¾	3
Gurum River	17	20	18
Jantar	12	16	15
Jos	13	15	14
Kaduna	21	20	18
Kaduna Prospectors	8	9	10
Kano	10	12½	–
Kuru	17	9	8
Kwall	10	8	7
Lower Bisichi	7	6¾	6
Lucky Chance	1	2	2½
Minna	8	3	3
Mongu	50	50	50
Naraguta	38	27	28
Naraguta Extended	17	15	14
Nigerian Consolidated	–	–	10¾
Ninghi	9	7	11
N.N. Bauchi	40	40	40
Offin River	19	16	16
Rayfield	40	40	45
Ropp	90	73	56
Rukuba	6	6½	6
South Bukeru	12	10	10
Sybu	1	⅝	1½
Tin Fields	5	6	7
Federated Malay States:			
Chenderiang	–	–	73*
Gopeng	60	60	62½
Idris Hydraulic	26	23	23¾
Ipoh	14	11½	14½
Kamunting	–	–	95*
Kinta	36	37¼	38¾
Lahat	30	32¾	32¾
Malayan Tin	53	44½	65½
Pahang	173	195	189
Rambutan	24	21	18
Sungei Besi	32	31	32
Tekka	39	36	41½
Tekka-Taiping	33	27	32½
Tronoh	100	80	54
Cornwall:			
East Pool	70	59	71
Geevor	27	33½	30¾
Grenville	37	32¾	35
South Crofty	42	45¾	47½
Other Countries:			
Aramayo Francke (Bolivia)	186	147	247
Berenguela (Bolivia)	33	29	31
Briseis (Tasmania)	12	15	24
Deebook (Siam)	18	13	20
Mawchi (Burma)	123	116	120
Porco (Bolivia)	–	26	25
Renong (Siam)	63	27	35¼
Rooiberg Minerals (Transvaal)	28	45	60
Siamese Tin (Siam)	115	114	82
Tongkah Harbour (Siam)	76	73	89
Zaaiplaats (Transvaal)	20	20	22

* Three months.

Nigerian Tin Production.

In long tons of concentrate of unspecified content.

Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1915	1916	1917	1918	1919	1920
	Tons	Tons	Tons	Tons	Tons	Tons
January	417	531	667	678	613	547
February	358	528	646	668	623	461
March	418	547	655	707	606	488
April	444	486	555	584	546	—
May	357	536	509	525	483	—
June	373	510	473	492	484	—
July	455	506	479	545	481	—
August	438	498	551	571	616	—
September	442	535	538	520	561	—
October	511	584	578	491	625	—
November	467	679	621	472	536	—
December	533	654	655	518	511	—
Total	5,213	6,594	6,927	6,771	6,685	1,496

Production of Tin in Federated Malay States.

Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1916	1917	1918	1919	1920
	Tons	Tons	Tons	Tons	Tons
January	4,316	3,558	3,149	3,765	4,265
February	3,372	2,755	3,191	2,673	3,014
March	3,696	3,286	2,608	2,819	2,770
April	3,177	3,251	3,308	2,855	2,606
May	3,729	3,413	3,332	3,404	—
June	3,435	3,489	2,950	2,873	—
July	3,517	3,253	3,373	3,756	—
August	3,732	3,413	3,259	2,955	—
September	3,636	3,154	3,166	3,161	—
October	3,681	3,436	2,870	3,221	—
November	3,635	3,300	3,131	2,972	—
December	3,945	3,525	3,023	2,413	—
	43,871	39,833	37,370	36,867	12,655

Total Sales of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
July 14, 1919	145	£18,250	£125 17 3
July 28	122	£16,939	£138 16 11
August 11	127½	£17,125	£134 6 5
August 25	130½	£18,297	£140 4 3
September 8	115½	£16,588	£143 12 6
September 22	135½	£19,557	£144 6 9
October 8	72	£10,867	£150 18 7
October 20	32	£5,093	£159 3 2
November 3	34½	£5,235	£151 15 0
November 17	39	£6,161	£157 19 9
December 1	38	£5,905	£155 8 3
December 15	29	£5,133	£176 10 0
December 31	14¾	£2,884	£195 10 10
Total and Average, 1919	2,858	£366,569	£128 5 0
January 12, 1920	31	£6,243	£201 8 0
January 26	51¾	£10,574	£204 6 10
February 9	37½	£7,880	£210 2 8
February 23	53¾	£12,120	£225 10 0
March 8	18	£4,038	£224 7 7
March 22	44	£8,286	£188 6 8
April 6	44½	£8,367	£188 0 5
April 19	33½	£6,375	£190 6 0
May 3	61½	£11,641	£189 5 9

Details of Redruth Tin Ticketings.

	April 7		April 19	
	Tons Sold	Realized per ton	Tons Sold	Realized per ton
		£ s. d.		£ s. d.
Tincroft Mines	5	195 10 0	5	193 10 0
,, ,,	6	195 10 0	5½	194 10 0
Penryn Minerals	6½	155 0 0	10	171 10 0
,, ,,	5	176 0 0	–	—
Levant	11	197 7 6	13	201 15 0
,, ,,	11	195 12 6	–	—
Total	44½		33½	

STOCKS OF TIN
Reported by A. Strauss & Co. Long Tons.

	March 31.	April 30.
	Tons	Tons
Straits and Australian Spot	1,431	997
Ditto, Landing and in Transit	1,306	720
Other Standard, Spot and Landing	1,225	1,186
Straits, Afloat	1,165	[illegible]
Australian, Afloat	332	332
Banca, in Holland	3,817	4,167
Ditto, Afloat	1,460	2,084
Billiton, Spot	—	—
Billiton, Afloat	56	[illegible]
Straits, Spot in Holland and Hamburg	—	
Ditto, Afloat to Continent	365	77
Total Afloat for United States	4,274	5,610
Stock in America	2,848	2,676
Total	18,279	18,716

SHIPMENTS, IMPORTS, SUPPLY, AND CONSUMPTION OF TIN.
Reported by A. Strauss & Co. Long tons.

	March	April
Shipments from:	Tons	Tons
Straits to U.K.	820	750
Straits to America	1,585	3,045
Straits to Continent	390	77
Straits to Other Places	157	280
Australia to U.K.	250	200
U.K. to America	322	1,355
Imports of Bolivian Tin into Europe	1,403	2,016
Supply:		
Straits	2,795	3,872
Australian	250	200
Billiton	56	175
Banca	707	1,009
Standard	1,108	449
Total	4,916	5,705
Consumption:		
U.K. Deliveries	2,389	1,578
Dutch ,,	—	
American ,,	5,195	3,305
Straits, Banca & Billiton, Continental Ports, etc.	525	385
Total	8,109	5,268

* Estimated.

DIVIDENDS DECLARED BY MINING COMPANIES

[illegible]	Company	[illegible]	[illegible]
May [illegible]	Anglo-French Exploration	[illegible]	[illegible] less tax
April 26	Aramayo Francke	[illegible]	[illegible] less tax
April 23	Arizona Copper	[illegible]	[illegible]
May 11	Ashanti Goldfields	4s.	[illegible]
April 23	Broken Hill Proprietary	[illegible]	9d
April 24	Chinese Engineering and Mining	£1.	2s tax free
April 15	Gold Coast Amalgamated	£1.	2s. 6d. less tax
April 15	Gold Fields Rhodesian	10s	[illegible] less tax
May 10	GurumRiver(Nigeria) Tin	10s.	9d. less tax
April 5	International Nickel	[illegible]	[illegible]
May 8	Kaduna Prospectors	5s.	1s. 6d. less tax
May 8	Kaduna Syndicate	5s	1s. 3d. less tax
April 21	Lonely Reef	£1	bonus 5s. less tax
April 10	Marbella Iron Ore	£3.	6s. less tax
May 4	Mongu (Nigeria) Tin	10s.	[illegible] less tax
April 13	Pahang Consolidated	Pref. £1	8⅜d less tax
April 27	,,	Ord. 5s.	[illegible] less tax
April 19	Premier(Transvaal) Diamond	Def. [illegible] 6d	15s. less tax
April 21	Premier(Transvaal) Diamond	Pref. 5s.	6s. 3d. less tax
May 8	Rambutan	[illegible]	1s. less tax
April 12	Renong Tin Dredging	£1.	1s. 6d. less tax
May 8	Scottish Australian	£1	3⅜d. less tax
April 10	South Crofty	5s.	6d. tax free
April 30	Union Corporation	12s. 6d.	[illegible]
April 30	Waihi	[illegible]	1s. tax free
April 19	Wolhuter	£1.	1s [illegible]

PRICES OF CHEMICALS. May 7.

		£	s.	d.
Alum	per ton	16	10	0
Alumina, Sulphate of	,,	16	10	0
Ammonia, Anhydrous	per lb.		2	0
,, 0·880 solution	per ton	37	10	0
,, Carbonate	per lb.			7½
,, Chloride of, grey	per ton	60	0	0
,, ,, ,, pure	per cwt.	5	5	0
,, Nitrate of	per ton	80	0	0
,, Phosphate of	,,	130	0	0
,, Sulphate of	,,	[illegible]	0	0
Antimony Sulphide, Golden	per lb.		1	6
Arsenic, White	per ton	70	0	0
Barium Sulphate	,,	12	0	0
Bisulphide of Carbon	,,	60	0	0
Bleaching Powder, 35% Cl.	,,	20	0	0
Borax	,,	41	0	0
Copper, Sulphate of	,,	48	0	0
Cyanide of Sodium, 100%	per lb.			11
Hydrofluoric Acid	,,			7½
Iodine	,,		16	0
Iron, Sulphate of	per ton	4	0	0
Lead, Acetate of, white	,,	97	0	0
,, Nitrate of	,,	67	0	0
,, Oxide of, Litharge	,,	70	0	0
,, White	,,	75	0	0
Lime, Acetate, brown	,,	[illegible]0	0	0
,, ,, grey 80%	,,	[illegible]	0	0
Magnesite, Calcined	,,	[illegible]	0	0
Magnesium, Chloride	,,	17	0	0
,, Sulphate	,,	12	0	0
Methylated Spirit 64° Industrial	per gal.		5	7
Phosphoric Acid	per lb.		1	9
Potassium Bichromate	per lb.			[illegible]
,, Carbonate 85%	per ton	115	[illegible]	[illegible]
,, Chlorate	per lb.		1	0
,, Chloride 80%	per ton	25	[illegible]	0
,, Hydrate (Caustic) 90%	,,	[illegible]	0	0
,, Nitrate	,,	[illegible]	0	0
,, Permanganate	per lb.		5	[illegible]
,, Prussiate, Yellow	,,			[illegible]
,, Sulphate, 90%	per ton	[illegible]5	0	[illegible]
Sodium Metal	per lb.		1	3
,, Acetate	per ton	59	0	0
,, Arsenate [illegible]	,,	60	0	0
,, Bicarbonate	,,	8	10	[illegible]
,, Bichromate	per lb			9
,, Carbonate (Soda Ash)	per ton	15	0	0
,, ,, (Crystals)	,,	[illegible]	10	0
,, Chlorate	per lb			6
,, Hydrate, 76%	per ton	27	0	0
,, Hyposulphite	,,	[illegible]	10	0
,, Nitrate, 95%	,,	[illegible]6	0	0
,, Phosphate	,,	38	0	0
,, Prussiate	per lb		1	9
,, Silicate	per ton	12	0	0
,, Sulphate (Salt-cake)	,,	6	0	0
,, ,, (Glauber's Salts)	,,	9	0	0
,, Sulphide	,,	56	0	0
Sulphur, Roll	,,	22	0	0
,, Flowers	,,	22	0	0
Sulphuric Acid, Non-Arsenical, 140°T.	,,	5	0	0
,, ,, ,, 90%	,,	7	5	[illegible]
,, ,, ,, 96%	,,	9	7	6
Superphosphate of Lime, 18%	,,	[illegible]	0	0
Tartaric Acid	per lb.		4	0
Zinc Chloride	per ton	27	0	0
Zinc Sulphate	,,	23	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	May 7 1919 £ s. d.	May 5 1920 £ s. d.
RAND:		
Brakpan	3 11 3	2 17 6
Central Mining (£8)	8 17 6	8 15 0
City & Suburban (£4)	12 0	5 3
City Deep	2 17 6	2 11 3
Consolidated Gold Fields	1 17 6	1 12 0
Consolidated Langlaagte	1 1 3	1 1 3
Consolidated Main Reef	15 0	11 9
Consolidated Mines Selection (10s.)	1 7 6	1 9 9
Crown Mines (10s.)	2 5 0	2 17 6
Daggafontein	1 6 9	15 6
Durban Roodepoort Deep	8 6	7 6
East Rand Proprietary	5 6	8 0
Ferreira Deep	13 9	11 6
Geduld	2 12 0	2 3 9
Geldenhuis Deep	10 9	8 0
Gov't Gold Mining Areas	4 13 9	4 7 6
Heriot	15 0	6 6
Johannesburg Consolidated	1 7 0	1 9 6
Jupiter	4 6	4 6
Kleinfontein	13 0	9 0
Knight Central	7 0	3 9
Knights Deep	8 3	7 6
Langlaagte Estate	1 1 6	15 6
Meyer & Charlton	4 11 3	4 10 0
Modderfontein (10s.)	26 15 0*	3 10 0
Modderfontein B	8 3 9	6 10 0
Modder Deep (5s.)	7 10 0†	2 7 6
Modder East	—	1 5 0
New State Areas	—	1 8 9
Nourse	14 0	10 6
Rand Mines (5s.)	3 1 3	2 18 9
Rand Selection Corporation	4 5 0	3 18 9
Randfontein Central	13 0	16 0
Robinson (£5)	13 9	9 0
Robinson Deep A (1s.)	18 9	1 0 0
Rose Deep	17 6	16 3
Simmer & Jack	4 6	5 0
Simmer Deep	2 9	1 6
Springs	3 3 9	2 6 3
Sub-Nigel	1 8 9	15 0
Union Corporation (12s. 6d.)	15 9	1 1 6
Van Ryn	16 3	17 6
Van Ryn Deep	3 10 0	4 7 6
Village Deep	16 6	11 0
Village Main Reef	12 0	6 6
West Springs	—	18 9
Witwatersrand (Knight's)	1 3 0	16 3
Witwatersrand Deep	14 0	9 0
Wolhuter	4 3	5 9
OTHER TRANSVAAL GOLD MINES:		
Glynn's Lydenburg	1 2 0	13 9
Transvaal Gold Mining Estates	14 6	13 9
DIAMONDS IN SOUTH AFRICA:		
De Beers Deferred (£2 10s.)	20 5 0	24 15 0
Jagersfontein	5 0 0	4 17 6
Premier Deferred (2s. 6d.)	7 7 6	11 5 0
RHODESIA:		
Cam & Motor	7 6	11 0
Chartered British South Africa	1 0 6	18 6
Falcon	13 6	10 6
Gaika	18 9	12 6
Giant	7 3	8 0
Globe & Phœnix (5s.)	1 8 9	14 6
Lonely Reef	2 10 0	3 0 0
Rezende	5 18 9	3 0 0
Shamva	2 0 6	1 15 0
Willoughby's (10s.)	6 9	5 6
WEST AFRICA:		
Abbontiakoon (10s.)	5 0	3 3
Abosso	7 0	11 0
Ashanti (4s.)	1 5 0	19 0
Prestea Block A	5 0	3 3
Taquah	16 3	15 0
WEST AUSTRALIA:		
Associated Gold Mines	4 0	3 6
Associated Northern Blocks	4 0	3 0
Bullfinch	1 6	6 0
Golden Horse-Shoe (£5)	1 13 9	18 9
Great Boulder Proprietary (2s.)	11 6	8 6
Great Fingall (10s).	2 3	2 6
Hampton Properties	—	1 5 0
Ivanhoe (£5)	2 0 0	1 10 0
Kalgurli	12 3	12 6
Lake View Investment (10s.)	18 6	17 0
Sons of Gwalia	7 0	6 9
South Kalgurli (10s.)	6 0	5 3

GOLD, SILVER, cont.	May 7 1919 £ s. d.	May 5 1920 £ s. d.
OTHERS IN AUSTRALASIA:		
Blackwater, New Zealand	8 9	8 9
Consolidated G.F. of New Zealand	3 9	3 9
Mount Boppy, New South Wales	3 9	4 0
Progress, New Zealand	1 9	1 9
Talisman, New Zealand	12 6	8 9
Waihi, New Zealand	2 2 6	2 0 0
Waihi Grand Junction, New Z'lnd	14 6	10 0
AMERICA:		
Buena Tierra, Mexico	1 0 0	12 6
Camp Bird, Colorado	1 1 3	13 0
El Oro, Mexico	1 1 3	12 6
Esperanza, Mexico	14 6	11 6
Frontino & Bolivia, Colombia	12 0	12 6
Le Roi No. 2 (£5), British Columbia	8 9	10 0
Mexico Mines of El Oro, Mexico	7 17 6	6 10 0
Nechi (Pref. 10s.), Colombia	12 0	10 0
Oroville Dredging, Colombia	1 7 0	1 3 9
Plymouth Consolidated, California	1 6 3	18 9
St. John del Rey, Brazil	18 9	16 6
Santa Gertrudis, Mexico	1 7 0	1 3 9
Tomboy, Colorado	15 0	12 6
RUSSIA:		
Lena Goldfields	1 12 6	1 5 0
Orsk Priority	15 0	12 6
INDIA:		
Balaghat (10s.)	4 3	8 9
Champion Reef (2s. 6d.)	4 6	3 6
Mysore (10s.)	2 0 0	1 1 3
North Anantapur	3 0	4 0
Nundydroog (10s.)	18 6	13 9
Ooregum (10s.)	16 0	16 3
COPPER:		
Arizona Copper (5s.), Arizona	2 0 0	2 12 6
Cape Copper (£2), Cape and India.	2 7 6	1 7 6
Esperanza, Spain	6 0	5 9
Hampden Cloncurry, Queensland	1 0 0	15 0
Mason & Barry, Portugal	2 13 9	2 10 0
Messina (5s.), Transvaal	5 0	5 6
Mount Elliott (£5), Queensland	3 5 0	2 10 0
Mount Lyell, Tasmania	1 3 0	1 5 0
Mount Morgan, Queensland	1 4 6	1 2 6
Mount Oxide, Queensland	5 0	7 0
Namaqua (£2), Cape Province	1 15 0	1 10 0
Rio Tinto (£5), Spain	55 10 0	35 0 0
Russo-Asiatic Consd., Russia	—	12 0
Sissert, Russia	1 15 0	12 6
Spassky, Russia	1 15 0	1 0 0
Tanganyika, Congo and Rhodesia	4 5 0	2 1 3
LEAD-ZINC:		
BROKEN HILL:		
Amalgamated Zinc	1 3 0	1 7 6
British Broken Hill	2 8 9	2 0 0
Broken Hill Proprietary (8s.)	2 5 3	3 0 0
Broken Hill Block 10 (£10)	1 7 0	1 6 3
Broken Hill North	2 13 0	2 13 9
Broken Hill South	2 10 0	2 15 0
Sulphide Corporation (15s.)	1 4 9	16 3
Zinc Corporation (10s.)	1 4 0	1 0 0
ASIA:		
Burma Corporation	6 15 0	10 0 0
Russian Mining	1 0 0	11 3
RHODESIA:		
Rhodesia Broken Hill (5s.)	13 9	13 0
TIN:		
Aramayo Francke, Bolivia	3 8 9	4 12 6
Bisichi, Nigeria	15 9	14 0
Briseis, Tasmania	5 3	5 3
Dolcoath, Cornwall	8 0	5 6
East Pool (5s.) Cornwall	1 2 0	11 3
Ex-Lands Nigeria (2s.), Nigeria	2 6	3 9
Geevor (10s.) Cornwall	14 6	16 3
Gopeng, Malay	2 3 9	2 2 6
Ipoh Dredging, Malay	1 2 6	1 0 0
Kamunting, Malaya	1 18 9	2 10 0
Kinta, Malaya	2 10 0	2 16 3
Malayan Tin Dredging, Malay	2 12 6	2 5 0
Mongu (10s.), Nigeria	18 6	1 2 6
Naraguta, Nigeria	18 0	15 0
N. N. Bauchi, Nigeria (10s.)	7 6	6 9
Pahang Consolidated (5s.), Malay.	17 0	12 0
Rayfield, Nigeria	15 0	11 6
Renong Dredging, Siam	2 6 3	2 5 0
Ropp (4s.), Nigeria	1 5 3	11 6
Siamese Tin, Siam	3 7 6	4 7 6
South Crofty (5s.), Cornwall	1 15 0	13 9
Tehidy Minerals, Cornwall	14 0‡	1 3 9
Tekka, Malay	4 5 0	5 10 0
Tekka-Taiping, Malay	4 5 0	1 8 0
Tronoh, Malay	2 2 6	2 3 9

* £4 shares split into 8 of 10s. each. † £1 shares split into 4 of 5s. each. ‡ 10s. paid up.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

THE RAPID FORMATION OF LEAD ORE.

Mining and Metallurgy, the recently established organ of the American Institute of Mining and Metallurgical Engineers, contains a paper by H. A. Wheeler giving an example of rapid formation of lead ore at a mine in the Oklahoma zinc-lead district. He uses this example as an argument against the usual notion that lead and zinc deposits are always the result of prolonged, slow deposition. No doubt, where the ore-bearing solutions have been very weak or the precipitating conditions have been feeble, the ore accumulations have taken a long period of time, but deposition can be very rapid under favourable conditions, geologically speaking, and also extremely recent. In fact, the author is inclined to regard most, if not all, of the Mississippi Valley deposits of lead and zinc as probably being very young, at least not older than Tertiary, if not Quaternary, in age.

The extensive Joplin lead and zinc district, in south-western Missouri, which has been worked 60 years, and has numerous mines that were abandoned from 1 to 50 years ago, shows that the lead and zinc to-day are in an active condition of solution and re-deposition, although these two metals occur in the predominant form of sulphides. The mine waters from the older and more or less abandoned portions of the district are frequently so acid, mainly from the oxidation of associated pyrite, as to necessitate the use of wooden pipes and pumps.

The first boom in the Oklahoma zinc field, which is the south-western extension of the Joplin district, occurred when ore was accidentally struck in drilling a water well. Among the mines then opened was the Mission mine, at Lincolnville, Ottawa County. This mine was opened in 1903 in lean "sheet ground," or a flat blanket formation of chert carrying disseminated blende and galena. The ore-body was very free from iron pyrites and the concentrates were very high grade. The lead concentrates assayed 80 to 85% lead and the blende assayed 60 to 65% zinc. The ore-body was shallow, occurring at a depth of 75 to 95 ft., and wet, requiring three or four pumps to handle the water. The mine was operated until 1914, when it was closed on account of litigation, and it immediately filled with water.

The second Oklahoma boom, five years ago, opened up the large active camps of Picher, Tar River, and Century, which are 2 to 5 miles west of Lincolnville. They are considerably deeper, being further down on the westwardly dipping monocline that emanates from the Ozark uplift in central Missouri, and they all had to contend with heavy reservoir water. The ore-bodies here occur in a highly fractured, more or less parallel series of zones that are very open; and while the pumping is heavy for one or two years in opening a mine, amounting to 1,000 to 3,000 gallons per minute, the inflow is very moderate after the reservoir water is exhausted. The Church and Mabon properties at Century, 3½ miles north-west of the Mission mine, had a heavy pumping proposition for over a year, but by 1916 the ground-water was exhausted, since which the Admiralty mine, one of the largest and deepest producers of this group, has had barely enough water for its mills.

On examining the Mission mine in 1916, it was found to have been completely drained by the Admiralty mine, 3½ miles distant, and the old iron tools left when it was abandoned two years earlier were found to be more or less coated with crystals of galena. These crystals ranged from $\frac{1}{80}$ to $\frac{1}{2}$ in. in size, and were intimately associated with limonite from the oxidation of the metallic iron. Some of the crystals were attached directly to the metallic iron, while others were inclosed in an amorphous limonitic mass that adhered tightly to the underlying iron and contained fragments of chert.

The author gives a photograph (not reproducible here) of an old railroad spike illustrating the mode or occurrence of this recently deposited galena. The spike probably rested on the floor of the drift. On the upper right-hand portion of the spike is an irregular mass of intermixed galena, limonite, and chert sand, the latter in angular fragments $\frac{1}{16}$ to $\frac{1}{4}$ in. in size. On this limonitic mass is a well-crystallized cube of galena about $\frac{1}{8}$ in. in size. On the lower left-hand portion of the spike is another galena crystal $\frac{1}{8}$ in. in size, and adjacent to it is a piece of chert at least $\frac{1}{2}$ in. long, which probably rested on the floor of the drift and is firmly cemented to the spike by limonite. On the left face of the spike, small galena crystals $\frac{1}{20}$ to $\frac{1}{4}$ in. in size are firmly attached to the spike by a limonite cement, and above them, resting on the top of the spike, is another mass of intermixed galena crystals and limonite with small fragments of chert. It is not unlikely that the entire spike was covered with limonite before it came into the possession of the author, as the specimen had been roughly handled during the months it was an object of curiosity in a mining office. The galena decidedly predominates in the limonitic matrix and, if scraped off, it would probably assay over 45% in metallic lead, possibly over 60%.

As the time from which the mine was abandoned until it was again drained was about two years, there was formed a very considerable deposition of lead sulphide in a period of time that, geologically speaking, is utterly insignificant, in fact, "a few geological moments." The precipitating conditions were of course exceptionally favourable, as the metallic iron would quickly decompose any soluble lead salts, whether as sulphate or bicarbonate. That the mine waters were extremely dilute seems probable, as the surrounding ore deposit was of low grade, yielding 1 to 5%, and was very shallow, or only 75 to 100 ft. deep. It is probable that the mine water was in active circulation during the submergence of the mine, especially during the last part of the period of deposition. For this district is so open with underground channels that mining activity in any part of the area would start a movement of the reservoir waters, even if there were no natural currents before mining was inaugurated, and considerable mining was in progress during the entire submergence of the property from 5 to 10 miles west, or further down on the monocline. In fact, in drilling this area with churn drills, the sludge is frequently washed away, on striking openings in the ore-bearing horizons, by the underground currents.

The presence of more or less chert in fragments in the adhering limonite certainly seems to indicate that the subterranean currents were sufficiently strong to move sand particles as coarse as $\frac{1}{20}$ to $\frac{1}{4}$ in., until they were trapped or arrested by the slimy limonite produced on the spike by the decomposition of the lead-bearing solution.

Another interesting feature brought out by this specimen is the fact that the large ore crystals do not necessarily mean slow growth. For while most of the galena occurs in small crystals, ranging from $\frac{1}{10}$ to $\frac{1}{4}$ in. in size, at least two crystals are $\frac{1}{2}$ in. in size and one of the latter was one of the latest to be formed, as it rests on top of a mass of the limonite-galena mixture.

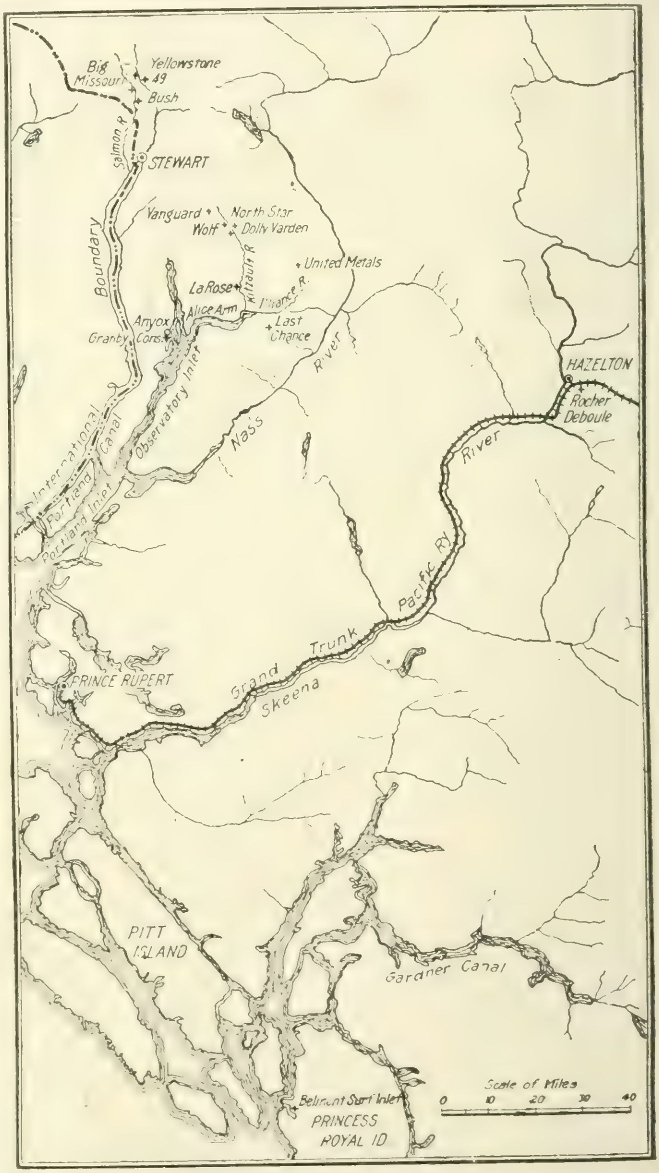
The evidence of this Mission mine leaves no doubt as to the ore-bodies of this district being a case of descension and shows that the ore horizons are steadily being lowered as erosion slowly planes away the surface. Since the Mission mine was reopened in 1916, it has been necessary to drill to a depth of 300 ft. to obtain sufficient water to operate the concentration mill, although it produced a great excess at 100 ft. in 1904, which was before the mines to the west and further down on the gentle monocline had been discovered.

THE DOLLY VARDEN SILVER MINE, B.C.

In the *Engineering and Mining Journal* for March 13, Robert Dunn gives particulars of the Dolly Varden silver mine, in the north-west of British Columbia. This mine is not far from the Premier silver-gold mine described in the Magazine for December last, and in many ways promises to be as remarkable.

Few British Columbian mining properties have passed through so varied an experience within a comparatively short space of time as has this mine. Discovered prior to 1913, it was first mentioned officially in the report of the Minister of Mines for that year, where it was stated that it was the first claim located on the upper reaches of the Kitsault River, that it was owned by Evindsen & Co., and that a general sample assayed 0·02 oz. gold, 1·4 oz. silver, and 1·2% copper. This is in marked contrast to results subsequently obtained from thorough sampling. The property was next heard of in 1915, during which season much exploratory and development work, aggregating about 550 ft. of tunnels and cross-cuts and 4,500 ft. of diamond-drilling, had been done, with the result that a considerable tonnage of very good silver ore was shown up, with indications of ore at greater depth, the metal contents being largely in the form of ruby and native silver in varying proportions, together with some horn silver. At this time the property was under bond to R. B. McGinnis, of San Francisco.

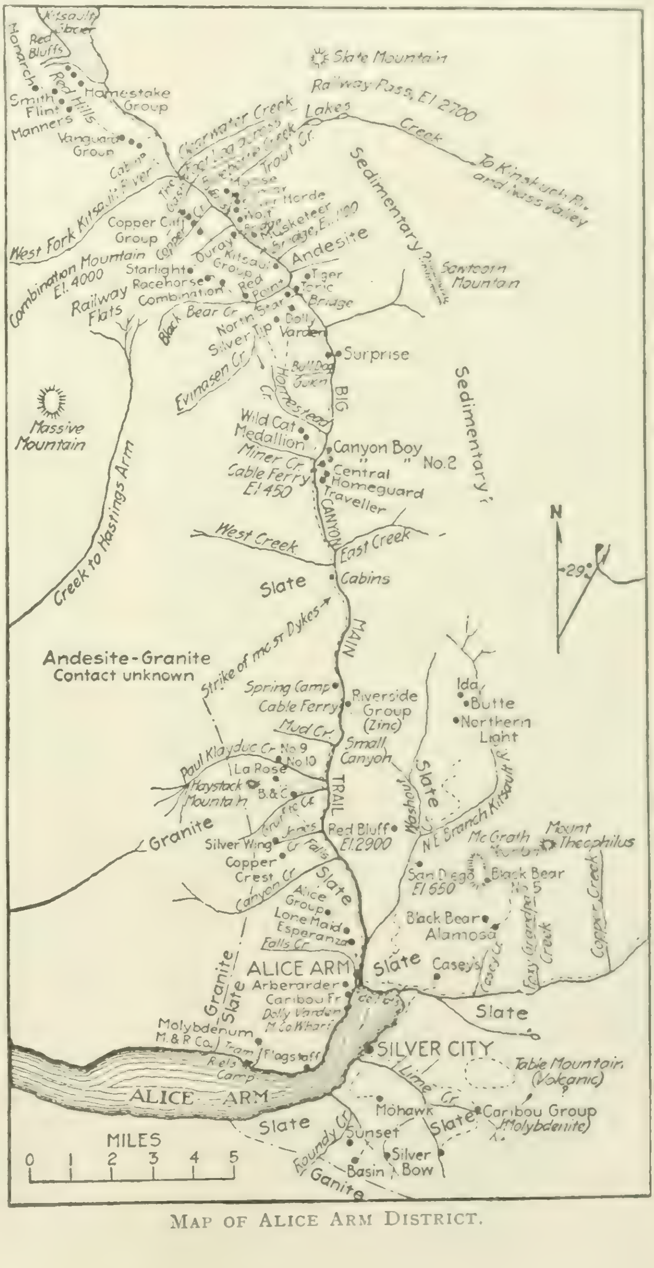
Largely through the success attending the opening up of the Dolly Varden, attention had been attracted to the Alice Arm mineral zone, and in 1916 the British Columbia Department of Mines assigned J. M. Turnbull, a mining engineer now at the head of the Department of Mining of the University of British Columbia, to make a general report on the section and on the properties under development there. Professor Turnbull's report deals, in general terms, with the geology of the country. The Alice Arm mineralized area lies wholly on the eastern side of the great Coast-Range granite (or granodiorite) batholith. The contact with



Map of Part of Northern British Columbia.

the granite crosses Alice Arm Inlet about four miles from its head, considerably west of Riel's Camp. Its course in a northerly direction for a distance of eight or ten miles is roughly parallel with that of the Kitsault River, which lies about three miles to the east. North of this the contact is not yet determined, but appears to swing more to the west. South of the inlet the contact seems to swing to the east to about the head of Lime Creek. In the southern portion of the area the rocks are predominantly shallow-water sedimentaries, occurring roughly in the following order: From the contact eastward, slates or argillites, tufaceous sandstones, quartzite, coarse reddish conglomerates with finer beds, and finally, at the head of the Illiance River, volcanic tuffs. The whole has been intruded by a great number of dark grey dykes, which seem to resemble the diorite dykes of the Portland Canal area and have a general tendency to strike in a north-east direction. Other intrusive rocks occur in places, the number of such occurrences being large. In the northern part of the area intrusive rocks seem to predominate, and the sedimentaries are either mere remnants or have been covered up by the igneous flows in part. Between the two a kind of mixed zone seems to occur, which was not followed by Professor Turnbull, except along the bottom of the Kitsault Valley. This zone shows a variety of rocks, slates, intrusives, and mixed rocks, which may be in part volcanic, either tufaceous, breccia-like, or full of inclusions. The sedimentary series seems to have a general strike to the north-west more or less parallel to the granite contact, and a general dip to the north-east, with local variations. In general, schistose structure is not conspicuous. Considerable disturbance has taken place, as is shown by the folding and faulting and the presence of the many dykes and intrusions, as well as by the numerous veins.

Of the Dolly Varden property as he found it in 1916, Professor Turnbull says: The mine camp and main workings, at 1,700 ft. elevation, are situated on the west side of the Kitsault River, the surveyed distance from the wharf being nineteen miles. The river at this point is about 1,000 ft. above the sea, and the hillside rises steeply from the water, past the mine, to an elevation of 2,200 ft.; then over the summit slopes more gently down to Evindsen Creek on the west. After describing the development as consisting at that time of 1,200 ft. of tunnels and rises and 5,500 ft. of diamond-drilling, besides numerous open-cuts, the report proceeds to deal with the mineralization as follows: The vein strikes approximately east and west, with a dip to the north of 45° and upward. Mineralization seems to follow a definite line or fissure, but extensive replacement also appears to have taken place, and ore occurs in widths up to 50 ft. or more. The mineralization consists of quartz, both white and of bluish tinge, accompanied by much pyrite, and smaller amounts of galena, ruby silver, native silver, argentite, zinc blende, and rhodocrosite or rhodonite. In places barite occurs in considerable quantity, but it does not seem to be associated with good ore to any extent. The original discovery was made on a projecting outcrop about 40 ft. wide. At first only trifling values were found, but on development very high values in silver soon appeared. A tunnel driven on the vein at this point encountered a cross-fault at about 50 ft. The continuation of the vein was later found to the north, showing a throw of about 75 ft. This second section behaves in much the same way,



MAP OF ALICE ARM DISTRICT.

and development has continued into a third section still farther north. Judging by surface outcrops this step-faulting is probably local. In general this ore presents great local variations in appearance and occurrence. In the third section good ore occurs, which is not much mineralized in appearance; in fact, it looks like country rock more than ore. and close sampling is necessary to follow it intelligently.

In 1917 the operators of the Dolly Varden mine incorporated and were empowered to transact business in British Columbia under the Companies Act as the Dolly Varden Mines Co., asking and obtaining special legislation from the province authorizing them to build a railway from a point at or near the Wolf group of mineral claims, about eighteen miles up the Kitsault River from its mouth to Alice Arm. It was distinctly set out that the company should complete and have its railway ready for operation before December 31, 1918, in default of which the rights and privileges conferred by the act would be null and void.

The next link in the historical chain is picked up in the report of the Minister of Mines for 1917, which asserted that the property, under the management of Mr. McGinnis, was being brought to a producing basis. The year's development consisted of railroad construction, of driving the main working tunnel, and of further exploration by means of diamond-drilling. Of the railroad construction, the contract for which was awarded to the Taylor Engineering Co., of Vancouver, B.C., it is said that the grade is finished for about twenty miles, but abnormal weather conditions prevented the finishing of more than about eight miles of track.

Discussing the Dolly Varden and the Wolf groups, with reference to activities during 1918, George Clothier, Government mining engineer, said that comparatively little work had been done on either property for the previous two years, the company devoting all its attention to building the railroad from the beach to the mine. As to the Dolly Varden, he says that development has shown that there are thousands of tons of shipping ore in sight and many thousands of milling ore available, and that with transportation and the installation of mining, milling, and power plants the property might be expected to develop into one of the important mines of the province.

The railroad was not completed by the date set by the Legislature, December 31, 1918, however, and an application was received at the 1918-1919 session of the Legislative Assembly for an extension of the time allowed for the work. Then opposition developed. A. J. T. Taylor, president of the Taylor Engineering Co., appeared before the Mining Committee of the House and charged that his company had not been paid for what had been done on the railway and that the failure of the Dolly Varden company to meet its obligations had brought him and his associates to the verge of bankruptcy. A thorough investigation followed, witnesses being examined in support of both parties to the dispute, and the result was the presentation to the House of a report of such a character that the legislation hereinafter outlined met with overwhelming endorsement. This legislation is known as the "Dolly Varden Mines Railway Act, Amendment Act, 1919." The Minister of Railways by this legislation was authorized to appoint a Justice of the Supreme Court of British Columbia to ascertain the actual cost of construction of the railway, and on receipt of his report copies were to be forwarded to the Dolly Varden Mines Co. and the Taylor Engineering Co, Within twenty-five days after receiving this report the Dolly Varden Mines Co. was to elect whether it would pay the contractors the amount of the actual cost of construction so ascertained. If that was its decision, it was required to make a sufficient payment, within the period named, to meet delinquent labour wages, and given an additional month to pay the balance. If, however, this offer was rejected, the Taylor Engineering Co. was to enter into full possession of the Dolly Varden Mine Co.'s holdings, including the mine, plant, railways, and other properties. Its title was subject to certain conditions. First, it was to pay delinquent wages in cash within fourteen days of entering into possession, and, second, other obligations were to be paid out of the net proceed of the premises, and the net proceeds were to be devoted exclusively to this purpose until the debts were liquidated. These charges are set out as being the unpaid balance of the purchase price of certain lots sold by Donald W. Cameron to the Dolly Varden company, together with interest on the amount in arrears; a floating charge in favour of George Wingfield, president of the Goldfield Consolidated Mines Co., upon the premises for the sum of $150,000, and interest thereon at the rate agreed upon under the existing mortgage; and a floating charge in favour of the Dolly Varden Mines Co. for the amount actually spent by the company on the property. This procedure was followed. The Dolly Varden Mines Co. did not take advantage of the opportunity to settle within the time limit. The Taylor Engineering Co. acquired possession, and, under the name of the Taylor Mining Co., has been operating the property. The Dolly Varden company has since given notice that the title of the Taylor Engineering Co. is to be attacked, and representations have already been made to the Department of Justice at Ottawa for a declaration that the legislation described is ultra vires of the Province of British Columbia. The first-mentioned company's suit had not advanced beyond this stage up to the time of writing.

With special provincial legislation behind it and an opportunity given for recouping losses if the mine turned out well, and with an ultimate possibility of being rewarded with profits, the Taylor Mining Co. took hold with remarkable energy. Work was taken up where it had been left off on the Dolly Varden railway on June 10, 1919. By September 1 it was completed to a point immediately below the mine, a 2,000 ft. two-bucket aerial tramway with upper and lower terminal bunkers was ready for operation, and mining actually began. Approximately 7,000 tons of ore averaging 56 oz. of silver to the ton was shipped to the smelter of the Granby Consolidated Mining, Smelting, & Power Co., Ltd., at Anyox, between September 1 and December 15. In addition, there has been delivered a small quantity of high-grade sacked ore averaging about 1,000 oz. Though operation of the railway has been suspended for the winter, mining is continuing, ore being stored ready for an early start in the spring. Communication is being maintained between Alice Arm and the mine by means of dog sleighs, and engineers are engaged in making a careful geological study of the property for the company's guidance in mapping out its programme for the forthcoming season.

A. J. T. Taylor, as managing director of the Taylor Mining Co., has announced that the railway from Alice Arm to the mine will be extended to the Wolf group of claims, a distance of about 2½ miles. A summer camp is to be opened at Wolf, which is a part of the company's holdings, for the purpose of development, and a water compressor is to be installed. New equipment is to be provided for the Dolly Varden mine, to permit extension of operations, and the rolling stock of the railway is to be increased. The North Star, Toric, Tiger, and Musketeer are among the properties that will be benefited by the proposed railway extension.

Mr. Clothier, in his preliminary report for 1919, says: "By the end of November, or five months from the time work was started, 6,373 tons of ore had been shipped, which will yield approximately 400,336 oz. silver. About forty tons of this was bonanza ore." Again: "The Dolly Varden . . . has made a most enviable record for the short time it has been shipping. This has established necessary confidence in the section, with the result that there are very few properties in the valley that are not being developed or under option. The situation at present gives every reason to believe that next year will see the greatest mining activity yet seen in a quartz camp in northern British Columbia. This feature (referring to the railway), together with the many extraordinary mineral showings in the silver belt, surely justifies a very optimistic outlook for the future." That Mr. Clothier's sanguine tone is warranted seems to be conclusively shown by the number of prospects under development and of which he has made special mention. Among these are the Last Chance group, on which diamond-drilling was started last season: the Ruby group, situated on the east side of the Kitsault River, opposite the Dolly Varden; the Central group, also on the Kitsault River and on which there has been considerable development and where some very high-grade ore has been extracted, and the Silver Star group on the Illiance River, across the river from the property of the United Metals Mining Company.

SOLUBILITY OF ZINC IN CYANIDE SOLUTIONS.

The December *Journal* of the Chemical, Metallurgical, & Mining Society of South Africa contains a paper by H. A. White describing experiments undertaken with a view to ascertain the solubility of zinc in cyanide solutions.

Very little research on this subject has been published, though it is one of great importance in reference to the precipitation of gold from cyanide solutions. The main object of the author's experiments was to observe the effect of various conditions which in practice might affect the consumption of zinc, and particularly the concentration of cyanide, alkalinity, and oxygen present. As there is probably some disadvantage in practice in dissolving more zinc than absolutely necessary to keep the extractors working efficiently, in this case a minimum rate of solution is of much more interest than is the case where gold is the object of attack.

The main reaction, in presence of oxygen, and with such concentrations of cyanide and alkali as are now in use, is:

$$
\begin{array}{lllll}
Zn & + 4KCy & + O & + H_2O = K_2ZnCy_4 + 2KOH \\
65{\cdot}37 & : 260{\cdot}44 & : 16{\cdot}0 & : 122{\cdot}22 \\
1{\cdot}000 & : 3{\cdot}984 & : 0{\cdot}2448 & : 1{\cdot}717 \\
0{\cdot}251 & : 1{\cdot}000 & : 0{\cdot}0618 & : 0{\cdot}4309 \\
0{\cdot}086 & : 16{\cdot}277 & : 1{\cdot}000 & : 7{\cdot}014 \\
0{\cdot}582 & : 2{\cdot}321 & : 0{\cdot}1426 & : 1{\cdot}000
\end{array}
$$

Therefore 6 mgm. of oxygen per litre is equivalent to 0·0089% KCy and to 24·5 mgm. of zinc per litre or 0·049 lb. of zinc per ton of solution.

However, it must be pointed out that, even in the absence of oxygen, some zinc may go into solution in accordance with the following equations:

$$
\begin{aligned}
Zn+4KCy+2H_2O &= K_2ZnCy_4 + 2KHO + H_2 \\
Zn+2KAuCy_2 &= K_2ZnCy_4 + 2Au \\
Zn+PbCy_2+2KCy &= K_2ZnCy_4 + Pb \\
Zn + Na_2S_2O_3 &= ZnS + Na_2SO_3 \\
Zn + 2NaHO &= Na_2ZnO_2 + H_2
\end{aligned}
$$

The first and last of these reactions were formerly of greater importance than at present, and their rate is increased, in presence of a zinc-lead or other couple, and high concentrations of cyanide or alkali. The fourth equation represents the reaction by which is formed the zinc sulphide coating so commonly found, and this matter deserves more attention than it has yet received.

The results are generally expressed in milligrams of zinc dissolved per square centimetre of exposed surface per 24 hours, which tacitly involves the assumption that variation of time or surface will yield proportionate figures, which is not necessarily exactly true, but gives a convenient comparison among different sets of experiments.

The zinc used was ordinary commercial sheet rolled down to about 0·3 mm. thickness and cut into rectangles 2·5 by 1·5 cm. After exposure, the pieces of zinc were washed in strong ammonia to remove any oxide formed, then in distilled water, and carefully dried with filter paper.

In each set of experiments the conditions were as nearly as possible alike, but no attempt was made to hold temperatures constant. Concentrations were determined before and after in each case, but only the average figures are quoted.

Experiment (*1*). Influence of oxygen concentration.

(a) De-aerated solution. A piece of zinc giving 7·5 sq. cm. of surface was suspended by a thread attached to a shaped glass rod in each of five 300 cc. stoppered bottles with solutions of varying cyanide strength, and no excess alkalinity, for 41 hours in moderate light. Temperature at start 31°C., at finish 27·5°C. Oxygen determined before start was 1·0 mgm. per litre, and at end about 0·5 mgm. per litre in each case.

KCy %	Oxygen mgm. per litre.	Zinc dissolved mgm. per sq. cm. per 24 hours.
0·100	[illegible]	[illegible]
0·050	0·75	0·16
0·030	0·75	0·17
0·020	0·75	0·18
0·010	0·75	0·19

With so little oxygen present the action is very slow and cyanide strength is of little importance. More than twice as much zinc is dissolved than corresponds with loss of oxygen, so that, unlike the case with gold, zinc is able to displace hydrogen in such solutions to a small extent.

(b) Aerated solution. The same pieces of zinc as in (a) were used, but solutions were made up with Rand Water Board water, precipitated with excess lime, so that the average alkalinity was 0·040% NaHO. 500 cc. jars open to air and moderate light were used, the zinc being hung on glass rods with thread. Temperature before trial 26°C. Oxygen at start 7·0 mgm. per litre. Exposure, 17 hours.

KCy %	Oxygen m.p.l.	Zinc dissolved mgm. per sq. cm. per 24 hours.
0·050	6·5	0·75
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
0·010	[illegible]	[illegible]

With plenty of oxygen present, cyanide strength is of importance, showing a maximum at about 0·020%. Even without use of zinc-lead couple, the importance of removing oxygen is manifest on comparing results in (a) and 1 (b).

Experiment (*2*). Influence of cyanide strength upon solution of zinc, with electrolytic contact.

(a) In contact with carbon. Pieces of zinc, 2·5 by 1·5 cm., were each bound to two carbon rods, of total surface 150 sq. cm., and placed at the bottom of 500 cc. glass jars filled with cyanide solutions of various strengths, and exposed for 19 hours. The alkalinity at the beginning was 0·0144% NaHO, the oxygen 6·5 mgm. per litre, and the temperature at start was 26°C., finishing at 25°C.

KCy %	NaHO	Oxygen m.p.l.	Zinc dissolved mgm. per sq. cm. per 24 hours
0·040	0·0120	4·0	3·12
0·025	0·0121	4·5	2·72
0·020	0·0122	4·5	2·76
0·010	0·0118	4·5	2·67
0·005	0·0118	4·5	2·62

The top side of the zinc was covered with white precipitate in half an hour in each case.

(b) In contact with lead. Pieces of zinc, as in (a), were balanced on top of lead cylinders made with lead foil, 3 by 5 cm., giving a lead surface of 30 sq. cm. 500 cc. glass jars were used, and the time of exposure was 18½ hours. Alkalinity at start was 0·0144% NaHO. Oxygen was 6·5 mgm. per litre. Temperature at start 24°C., finishing at 15°C.

KCy %	NaHO	Oxygen m.p.l.	Zinc dissolved mgm. per sq. cm. per 24 hours.
0·050	0·0130	5·0	1·67
0·025	0·0124	4·5	1·47
0·020	0·0122	4·5	1·42
0·010	0·0122	5·0	1·32
0·005	0·0122	5·0	1·23

While no white precipitate was apparent with the 0·050% KCy, increasing amounts appeared in the other cases as the cyanide strength was reduced.

Experiment (3). Influence of alkalinity upon solution of zinc in presence of 0·030% KCy.

(a) Freely suspended; (b) In contact with lead. The zinc and lead were used in exactly the same manner as in (2b) in 500 cc. open jars. The alkalinity was obtained by means of dilution of lime water, and the cyanide strength was made up to 0·030% in each case originally. The temperature at beginning was 27°C., and after the 18½ hours' exposure was 24°C.

		Zinc dissolved mgm. per sq. cm. per 24 hrs.	
NaHO	KCy	(a) Free suspension	(b) Contact with Lead
0·0456	0·030	0·47	1·20
0·0284	0·030	0·45	1·20
0·0115	0·030	0·45	1·21
0·0054	0·029	0·52	1·26
0·0020	0·021	0·50	1·18

In the first two solutions a trace of lead was visible on adding sodium sulphide and acetic acid, and in the third a very little white precipitate was seen. It is evident that, with free cyanide as high as 0·030%, alkalinity variations have very little effect.

Experiment (4). Influence of alkalinity upon solution of zinc in presence of 0·010% KCy.

(a) Freely suspended; (b) In contact with lead. The conditions were the same as in (3a) and (3b) except that cyanide strength was made up to 0·010% in each case and the exposure was 18 hours. Oxygen at beginning was 7·0 mgm. per litre. Temperature at start 29°C., and end 23°C.

			Zinc dissolved mgm. per sq. cm. per 24 hours	
NaHO	KCy	Oxygen m.p.l.	(a) Free suspension	(b) Lead contact
0·0463	0·010	7·0	0·28	0·24
0·0295	0·010	6·0	0·27	0·25
0·0113	0·010	4·7	0·31	1·23
0·0052	0·010	4·7	0·40	1·29
0·0010	0·008	4·7	0·38	0·68

White precipitate appeared only in the third and fourth cases, and in the first two cases the lead had been attacked, the solution showing a heavy precipitate of lead sulphide in the first case and somewhat less in the second. There is evidently an inversion point in the electrolytic effect, at this cyanide strength, with solution above 0·030% NaHO, and such high alkalinity might endanger the work of the extractor boxes at low cyanide strengths. These results should be compared with (3) to see the extraordinary difference which is produced by decrease of cyanide strength from 0·030 to 0·010%, and this is corroborated by (5) where the effect of entirely removing the cyanide is shown.

Experiment (5). Influence of alkalinity upon solution of zinc in absence of cyanide.

(a) Freely suspended; (b) In contact with lead foil. In both cases the alkalinity, though reported as NaHO, was obtained by dilution of lime water. In each 500 cc. jar used one piece of zinc, 2·5 by 1·5 cm., was suspended by cotton thread, and one piece was balanced on a lead cylinder of 30 sq. cm. area, as in experiment (2b). Exposure was 18½ hours, the temperature at start being 28°C., and at finish 24°C. Oxygen at beginning, 7·0 m.p.l.

		Zinc dissolved mgm. per sq. cm. per 24 hrs.	
NaHO	Oxygen	(a) Free suspension	(b) Lead contact
0·0412	7·0	0·00	0·03
0·0272	5·5	0·07	0·75
0·0176	5·7	0·32	0·85
0·0078	5·5	0·33	1·04
0·0018	5·7	0·31	1·14

No white precipitate appeared in the first and last cases, but a little was shown on both pieces of zinc in all the others. In the first two cases the lead foil was discoloured. It is very clear that such unusually high alkalinity as 0·040% NaHO practically hinders the reaction completely, and is reminiscent of the protective action of alkalies in boiler-feed water, where a certain minimum dose is required before protection commences. It is clear, however, that the alkalinity in cyanide solutions might be run up 0·030% as NaHO without danger of interference with precipitation.

Experiment (6). Effect of gold-bearing solutions upon zinc, in the absence of oxygen. Condensed water containing 0·75 mgm. per litre of oxygen was used for these experiments, in 300 cc. stoppered bottles. A strip of zinc 10 by 1 cm. was used in each case, and sodium auro-cyanide equivalent to 7·0 mgm. of gold per litre was placed in each bottle. In (B) and (C) a strip of lead measuring 5 by 5 cm., rolled into a cylinder, was placed to rest against the bottom of the zinc strip. In (B) the cyanide strength was made 0·021%, and in (D) 0·027%. The temperature at start was 27°C., and after the 18 hours' exposure was 24°C. Allowance was made for the gold precipitated in calculating the weight of zinc dissolved.

	KCy	NaHO	Gold pptd. mgm.	Zinc dissolved mgm. per sq. cm. per 24 hours
A	0·000	0·0008	0·00	0·08
B	0·021	0·0020	1·76	0·68 (Lead contact)
C	0·000	0·0048	0·15	0·13 (Lead contact)
D	0·027	0·0016	0·56	0·53
E	0·000	0·0048	0·00	0·10

In (A) and (E) the absence of free cyanide totally prevented precipitation of gold, though a little white precipitate was formed. In (C), though no cyanide was present, the zinc-lead couple was able to precipitate a little gold in black splashes and a trace of lead went into solution. In (D), in presence of free cyanide, the zinc alone was able to precipitate a fair amount of gold, in an even black coat. In (B) the zinc-lead couple began to get dark in 20 minutes, and though not much more zinc was dissolved than in (D), nearly three times as much gold was precipitated. In this case the zinc dissolved was 10 times the amount corresponding with the oxygen present, and 18 times that equivalent to the gold brought down and only the direct production of hydrogen can be called on to explain the differences.

Evidently the ideal of consuming only as much zinc in the extractor-boxes as would correspond with the gold and silver precipitated calls for close regulation of the cyanide strength and alkalinity, as well as the total absence of oxygen, and does not seem likely of attainment even in the absence of other side reactions such as the reduction of thiosulphates. The actual consumption of zinc in the usual extractor-boxes will average about 0·18 mgm. per sq. cm. per 24 hours, or about 3 times that rate in the first compartments, before the bulk of the oxygen is removed.

It is not possible to give an average figure for zinc consumed per ton of solution treated on the Witwatersrand, but a moderate assumption would be 0·1 lb. of zinc per ton of solution, carrying 2 dwt. of gold per ton. The various sources of this consumption would be roughly:

Gold and [illegible] precipitation	[illegible]
Combination with dissolved oxygen	49·0
Evolution of hydrogen	[illegible]
Taken for [illegible]	[illegible]
Used to precipitate lead [illegible] waste in cutting, used in forming ZnS coating, etc.	12·0

These figures are, of course, merely illustrative and are for the purpose of drawing attention to the present wasteful inefficiency of our present methods of gold precipitation.

Metallurgy at Golden Horse-Shoe.—In the December issue of the *Monthly Journal* of the Chamber of Mines of West Australia, C. E. Blackett gives an account of the practice in precipitation and clean-up at the cyanide plant of the Golden Horse-Shoe mine, Kalgoorlie.

Separate gold-bearing solutions are obtained from the slime, sand, and roasted concentrate plants, and these, together with all washes, gravitate to one common sump. The sump is provided with stirring gear to ensure the liquors being of uniform strength, both in cyanide and alkali, before they are delivered to the zinc extractor boxes. The mixed solution is then clarified, and subsequently delivered to the gold-solution storage-tanks, of which there are two, each 20 ft. by 8 ft. From them the solution flows to the precipitation boxes by means of two 4 in. mains. Twelve boxes are required to precipitate the gold from the cyanide solutions. They have a total zinc capacity of 480 cu. ft. The boxes are arranged with a fall of ½ in. per foot, and have an average capacity of 800 tons of solution per 24 hours.

The strength of the solution before and after precipitation is as follows:

	Free KCN. %	Protective Alkalinity. % CaO
Before	0·08	0·032
After	0·06	0·038

The precipitation boxes are dressed once each week by moving the zinc to the head of the box, and the lower compartments are replenished with fresh zinc. The shavings are not treated with lead acetate while dressing, but lead acetate or nitrate is added to the gold solution at the rate of 6 lb. per 24 hours, which is equal to 0·12 oz. per ton of solution. This method has been found more beneficial to precipitation than dipping the zinc in a solution of lead salts.

To distribute the flow of solution evenly over the boxes the solution, as it enters, passes through a wier box, the dimensions of which are 12 in. by 8 in. with a 1 in. by 5 in. slot.

Cleaning-up of the precipitate takes place bi-monthly, by removing the zinc from each compartment, and washing it over a 20 mesh screen fitted into a V trough. The arrangement of the plant is such that all the liquor syphoned from the boxes flows to one common montejus of sufficient capacity to hold the liquid contents of six extractors. All this solution is passed through the clean-up press before the actual collection of the zinc precipitate takes place. In washing the zinc, only that which is sufficiently rich is taken from the boxes, and any short zinc is washed and returned to the boxes evenly. No short zinc is dissolved by means of acid. It is customary to keep as little zinc exposed as possible to the atmosphere to avoid oxidation.

Four men are employed in washing, two men cleaning the screens and bottoms of the compartments, and two men syphoning off the solution and dressing the boxes. When all the precipitate has been collected and is contained in the washing trough, the contents are agitated and run into a small montejus, which delivers the precipitate by means of compressed air into a central-filling filter-press having 30 chambers. The precipitate is not treated with sulphuric acid. When the filter-press is charged, the contents are washed with cold fresh water for 40 minutes at a pressure of 50 lb. per sq. in., air dried, and discharged into iron trays provided with lids, which are locked and weighed. The resultant cake contains 30% of moisture.

Three cast-iron muffles are used, each 58 in. by 20 in. by 15 in., provided with movable cast iron trays to protect the bottoms of the muffle. About 300 lb. of precipitate is charged into each muffle, the door of which is locked by means of a special padlock.

It usually requires about twelve hours to thoroughly heat the contents of the muffle. Then the doors are unlocked and the precipitate is rabbled until the zinc is oxidized. This generally requires about three hours to accomplish, making the total time of roasting 15 hours. Great care must be taken to have the precipitate thoroughly heated before any rabbling is commenced, otherwise a considerable amount of dusting will take place, but providing this is carried out there is practically no loss in dusting during the roasting of the precipitate. It is now withdrawn from the retorts, placed in suitable trays, and locked in the strong room until all the precipitate is roasted and ready for smelting.

Analysis of Roasted Precipitate.

	%
Insoluble in Aqua Regia	2·45
Gold	21·06
Silver	[illegible]
Iron Oxide	[illegible]·45
Aluminium Oxide	1·37
Copper Oxide	3·49
Lead Oxide	9·05
Zinc Oxide	21·65
Calcium Oxide	[illegible]
Magnesium Oxide	0·61
Sulphuric Anhydride	6·64
Total accounted for	96·55

The smelting of the roasted precipitate is carried out in the Faber du Faur type of furnace. A feature is the use of gas carbon in this furnace. Gas carbon has great advantages as a fuel when compared with the best English coke, as it saves a considerable amount of labour, makes a large reduction in the fuel consumed, gives a higher temperature, and does not form any clinker in the furnace or on the fire-bars. When lighting the furnace an abundance of wood must be used, and the gas carbon fed in gradually until it is fully charged. It is necessary to light the furnaces about four hours before they are required. No addition of fuel is required to complete the smelt, and when the charge has been poured the fire-bars are withdrawn and the remaining gas carbon is quenched with water, after which it can be used again. The consumption of fuel amounts to 1¼ lb. of gas carbon to 1 lb. of precipitate.

The precipitate is fluxed in the following proportions: Precipitate 100 parts, borax glass 30 parts, quartz sand 8 parts, manganese dioxide 7 parts. This is thoroughly mixed on a concrete floor, but not sieved, as is sometimes practised, and is charged into the crucible by means of a specially designed chute. A No. 9 plain salamander crucible is used. It usually requires 2½ hours to complete each fusion, which, together with fluxes, weighs about 300 lb. Before pouring, the contents of the crucible are thoroughly stirred. The slag is collected in a slag-pot similar in design to those used in smelting works. The gold is poured into conical moulds, any adhering matte is scraped off, weighed, and the bullion is re-melted in a No. 30 salamander crucible. When the bullion is molten, nitre is added and stirred thoroughly; the slag is thickened by the addition of mabor and skimmed off. These skimmings are subsequently treated by amalgamation. The bullion is cast into ingot moulds which have previously been heated and coated with lamp black by turning them upside down over some burning oily waste. The slag is removed from the bars while they are red hot, and they are further cleansed by plunging into a pickle bath, and then washed with fresh water. Finally they are scrubbed with carbonate of soda, washed, dried, and weighed. Each bar is sampled by drilling to the depth of ¼ in. at the top and bottom.

The following is an example of the roasting and smelting of a half-monthly clean-up:

Weight of wet precipitate	1,519 lb.
H_2O	30%
Weight of dry precipitate	1·053·3 lb.
Bullion wet precipitate	21·98%
Weight after roasting	836 lb.
Bullion	39·95%
Weight smelted gold	4,862·7 oz.
Weight after re-melting	4,842·3 oz.
Loss in re-melting	20·4 oz.
Bullion Fineness:	
Gold	5331
Silver	4356
Base	313

The following is the cost of precipitation and smelting:

	Per Oz. Bullion. pence	Per Ton Treated (2,240 lb.). pence
Precipitation	5·17	3·95
Roasting	0·30	0·22
Smelting	2·34	1·77
Total	7·81	5·94

Cupferron as a Precipitant.—The *Journal of Industrial and Engineering Chemistry* for April contains a paper by G. E. F. Lundell and H. B. Knowles on the use of cupferron in the quantitative analysis of certain minerals. Cupferron is the ammonium salt of nitrosophenylhydroxylamine, $C_6H_5.N.NO.ONH_4$. It is being increasingly used for the determination of zirconium in its ores and metallurgical products, as well as for minor purposes such as the separation of iron and titanium from manganese and aluminium in limestone analysis. This paper presents a review of the literature dealing with the use of cupferron as a quantitative precipitant, and gives the results of many tests which were performed at the United States Bureau of Standards in connection with an attempt to adapt the cupferron method to the determination of zirconium in its ores and metallurgical products. Cupferron precipitates are salts in which the ammonium radical of the reagent has been replaced by metals. Precipitations are performed in cold solutions containing free mineral or organic acids. Cold solutions must be employed to prevent decomposition of the reagent into various organic substances, such as nitrobenzene, and the temperature of precipitation is usually specified as "cooled in ice water." The authors summarize the present status of cupferron as a quantitative precipitant as follows: Cupferron has been successfully used for the quantitative determination of copper, iron, titanium, zirconium, thorium, and vanadium. Many elements interfere with the determinations. In any given determination the partial or complete precipitation of copper, iron, titanium, zirconium, thorium, and vanadium must be considered in addition to the following known interfering elements: lead, silver, mercury, tin, bismuth, cerium, thorium, tungsten, uranium in the quadrivalent condition, silica, vanadium, and in certain cases when present in excessive amounts, phosphorus, alkali salts, and alkaline earths. The cupferron method should not be employed unless the qualitative composition of the material to be analysed is known, or a most careful quantitative examination of the ignited and weighed cupferron precipitate is made. Cupferron can be used advantageously in certain separations, such as iron from manganese, and iron and titanium from aluminium and manganese.

Mangnall's Boring Machine.—*The Engineer* for April 9 contains an illustrated description of Captain A. R. Mangnall's boring machine. This is worked by hydraulic pressure and is intended for piercing clay or other yielding material. It will drive a hole 4 in. diameter for a length of 150 ft. in half an hour. A notable feature is that no debris is removed from the hole.

The machine consists of a hydraulic cylinder made of steel tube, carried on trunnions in a light steel frame. The trunnions are near the closed or rearward end, and on them the barrel can be turned from a horizontal to an upright position. Inside the cylinder is a short piston with hinged guiding fingers. The barrel is capable of slight adjustment from the true horizontal by suitable training and elevating gear of a simple order. This "gun" complete on its framework is dropped into a pit dug in the ground to the depth required, a plate at the back of the framework or carriage pressing against a few timbers to distribute the load. The cylinder is connected by flexible pressure pipes to a little three-throw pump driven by a petrol engine. The exhaust water returns to the sump from which the pump draws. The operation of thrust boring is begun by turning the gun up to a vertical position and dropping the "pilot" into it. The gun is then turned down and clamped in position, and hydraulic pressure is admitted behind the piston, pressing the pilot horizontally into the soil. The stroke being completed, the admission valve is closed and the exhaust valve opened —by one and the same lever—the gun is raised to the vertical, and the first extension-piece pressed into it. The exhaust water is thus returned to the sump. The three guide fingers referred to keep the base of the extension-piece in a central position. The gun is again placed horizontally, and the extension piece is attached to the end of the pilot by a simple pin joint. The pressure is put on again, and the pilot driven forward another 4 ft. Then the same operation is repeated, extension-piece after extension-piece being added until the pilot breaks through into a pit at the far end, 150 ft. away. The pilot is then uncoupled and lifted out of the pit, and the extension-pieces are withdrawn and uncoupled one by one. The whole operation of raising the gun, inserting an extension piece, lowering the gun, fixing the pin joint, and thrusting the piece home occupies less than one miuute. The joint is simple and ingenious. The extension-pieces are tubes about 2½ in. diameter for a 4 in. hole, with muff couplings at the leading end. Through each coupling is drilled a pair of opposite holes; through the other end of each piece is drilled a corresponding pair of holes, but of smaller diameter. The pins are turned to fit the smaller holes freely, but at each end are reduced in diameter so as to leave a shoulder. The operator brings the holes opposite each other, slips the pin in position, and dabs a little bit of clay round the end. It is found that the clay locks the pins effectively, and that they never fall out. The withdrawal of the extension pieces is easy, since their diameter is a good deal less than that of the hole. The method generally employed is to attach a rope to the last piece and carry it round a pulley. Two or three men on the surface can then pull the whole chain of extension-pieces back until the next joint is reached. The operation is repeated until the operator in the pit can pull the rods back without assistance. An alternative method is to turn the gun up to a vertical position, and by means of suitably arranged ropes and pulleys employ it like the cylinder of a hydraulic crane. The overall working speed, start to finish, of a thrust boring 4 in. diameter is 300 ft. per hour.

SHORT NOTICES.

Stone-Dusting.—At the April meeting of the North of England Institute of Mining and Mechanical Engineers, L. G. Hill read a paper on stone-dusting in collieries.

Cleaning Pump Columns.—The *Journal* of the South African Institution of Engineers for March contains a paper by G. T. Andrews describing practice in cleaning pump columns in mines.

Ventilation of Mines.—At the March meeting of the Midland Institute of Mining, Civil, & Mechanical Engineers, R. Clive read a paper describing the running of two fans in parallel at the Bentley colliery.

Oil Drilling.—At the March meeting of the Institution of Petroleum Technologists, M. A. Ockenden and Ashley Carter read a paper on plant used in the rotary system of drilling oil wells.

The Chain-Spiral Pump.—*Engineering* for April 2 gives some particulars of this apparatus, consisting of a chain surrounded by a metal spiral, used for elevating water and other liquids.

Filters.—In *Chemical and Metallurgical Engineering* for March 17, D. R. Sperry discusses various types of filter plates and frames.

Cobalt Silver Ores.—*Economic Geology* for March contains a review of the opinions relating to the geology of the silver veins at Cobalt, and a paper by A. R. Whitman on diffusion in vein-genesis at Cobalt.

Refined Copper.—*Chemical and Metallurgical Engineering* for March 10 contains a paper by Lawrence Addicks on the market requirements as regards physical characteristics of refined copper.

Electrolytic Zinc.—*Chemical and Metallurgical Engineering* for March 24 contains an article by L. W. Chapman describing the electrolytic zinc plant of the Judge Mining & Smelting Company, at Park City, Utah.

Electrolytic Zinc.—In *Chemical and Metallurgical Engineering* for April 7, H. F. Bradley describes the methods of analysis employed at the laboratory of the electrolytic zinc works of the Judge Mining & Smelting Co., Park City, Utah.

Basic Slag.—At the March meeting of the Faraday Society several papers were presented on the employment of basic slag as a phosphate fertilizer.

Aluminium.—Walter Rosenhain has given a series of lectures before the Royal Society of Arts on aluminium and its alloys.

The Tungsten Position.—The *Journal* of the Society of Chemical Industry for March 31 contains a review of the present position of the tungsten industry, written by Julius L. F. Vogel.

Refractory Materials in Victoria.—*Chemical Engineering and Mining Review* (Melbourne) for February contains a paper on the resources of refractory materials in Victoria.

Coal in Iceland.—At the April meeting of the Mining Institute of Scotland, H. H. Eriksson read a paper on coal-mining in Iceland.

Natal Coalfield.—The *Transactions* 1919 of the Geological Society of South Africa contains a paper by F. A. Steart on the geology of the north-western part of the Natal coalfield.

Sabi Valley.—The *Transactions* 1919 of the Geological Society of South Africa contains a paper on the geology of the Sabi Valley, Mashonaland, by F. P. Mennell.

Kennecott, Alaska.—*Economic Geology* for February contains an elaborate paper by A. M. Bateman and D. H. McLaughlin on the geology of the Kennecott copper deposits, Alaska.

Philippine Mining.—In the *Mining and Scientific Press* for April 3, C. M. Eye reviews the progress of mining in the Philippine Islands during 1919.

Classification of Igneous Rocks.—In the *Journal of Geology* Albert Johannsen gives a revision of his quantitative mineralogical classification of igneous rocks.

Trade Routes of British Africa.—The *Journal* of the Royal Society of Arts for April 2 contains a paper by G. F. Scott Elliott on trade routes for the British Empire in Africa. It gives useful information with regard to British and "German" East Africa.

Anatolia.—The *Geographical Journal* for April contains a paper by Captain E. H. Keeling on Northern Anatolia.

West Africa.—The *Geographical Journal* for April contains a paper by Sir Alfred Sharpe on the hinterland of Liberia.

H. C. Hoover.—In the *Mining and Scientific Press* for April 3, T. A. Rickard gives a character sketch of Herbert C. Hoover.

RECENT PATENTS PUBLISHED.

☞ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.2., with a note of the number and year of the patent.*

12,590 of 1917 (109,271). FRIED KRUPP GRUSONWERK, and W. KAUFFMANN, Magdeburg-Buckau, Germany. In roasting and calcining furnaces of the cylindrical revolving type, a method of controlling the air inlet so as to allow more air at the front end than at the far end.

7,661 of 1918 (140,114). P. L. HULIN, Grenoble, France. Method of dehydrating unstable metallic chlorides by heating with hydrochloric acid gas.

17,167 and 19,135 of 1918 (140,484). G. CALVERT, London. Improved method of conducting the operation of producing cyanide compounds by the reaction of alkali carbonate, carbon, and nitrogen in presence of iron-powder catalyst.

18,030 of 1918 (139,535). LUCKENBACH PROCESSES, INCORPORATED, San Francisco. The use of rubber or resin dissolved in near-turpentine as a selective agent in the flotation process.

19,585 of 1918 (140,844). J. J. Hood, London. Removing impurities from sulphur by passing it when molten through a filter of ignited bauxite or ignited magnesite.

21,068, 21,069, and 21,070 of 1918 (140,507, 140,508, and 140,509). Societe Anonyme de Commentry Fourchambault et Decazeville, Paris. A series of special steels containing 20 to 60% nickel, 10 to 15% chromium, with smaller varying amounts of manganese, molybdenum, vanadium, cobalt, or tungsten. These steels are useful for parts of machinery exposed to steam at high temperatures.

2,288 of 1919 (124,715). F. F. Boisselier, Colombes, France. A solder for aluminium consisting of 28% Al, 37·5% Zn, 33% Sn, and 1·5% Cu.

5,605 of 1919 (140,578). G. H. Benjamin, New York. Improvements in tunnel kilns.

7,999 of 1919 (140,217). P. H. Wilson, Chesterfield. Apparatus for registering the flow of air and other gases through pipes and ducts.

9,510 of 1919 (139,661). R. P. Park, Melbourne. Method of imparting pulsating motion to the water in jigs.

9,909 of 1919 (140,621). T. A. C. Walden, South Shields. Locking devices for holding ore cars n place in the cage.

11,019 of 1919 (140,915). H. Jones and Ernest Newell & Co., Ltd., Gainsborough. Improved plant for the manufacture of superphosphates.

11,913 of 1919 (130,963). C. Rossi, Legnana, Italy. Submitting potash-bearing rocks mixed with calcium carbide to the action of nitrogen in a furnace together with carbon and lime, the products being calcium cyanamide and sublimed potash compounds.

12,502 of 1919 (140,266). W. W. Richardson, London. Improvements in the inventor's system of concentrating by means of rotating cylinders.

13,597 and 17,785 of 1919 (140,278). T. H. Leathart and Locke, Blackett & Co., Ltd., Newcastle-on-Tyne. In the preparation of pure lead suitable for chemical plant, removing zinc, arsenic, antimony, etc., by adding sodium and heating to redness.

14,111 of 1919 (139,967). H. D. Cunningham, Brighton. Method of preparing aluminium surfaces for electro-plating.

14,958 of 1919 (130,966). Norsk Hydro-Elektrisk Kvaelstofaktieselskab, Kristiania, Norway. The addition of small percentage of nitric acid to sulphuric acid that contains nitrogen oxides, the effect being to prevent the sulphuric acid from attacking iron.

14,989 of 1919 (140,943). U. C. Tainton, Martinez, California. In order to prevent the formation of zinc ferrate in roasting blende ores containing pyrite, grinding the ore sufficiently fine to separate the sulphides, injecting them into the furnace, and cooling while still in suspension.

16,588 of 1919 (140,948). A. Sinclair, Sunderland. Improved construction of cupola furnace.

17,044 of 1919 (140,952). R. W. Cuthbertson, Bolton. A metallic pit prop having a cross section consisting of an incomplete circle or square.

17,573 of 1919 (140,294). W. F. Read-Wale, Woking. Improved method of coating iron articles with tin or tin alloy.

17,991 of 1919 (140,297). E. A. Barnes, Allentown, Pa. Preparation of barium hydroxide from barium sulphide.

18,392 of 1919 (140,301). A. L. Barbe, Asnières, France. Method of making a white pigment from oxide of antimony.

COMPANY REPORTS

Ivanhoe Gold Corporation.—Interest in West Australian mining matters has been diverted to the Hampton Plains district by the new gold discoveries that have been made there, and the old Kalgoorlie, or "Golden Mile" propositions appear to have been adversely affected to a certain extent by the rush to the new field, or, rather, old field resuscitated. The directors of the Ivanhoe, for instance, point out in their annual report that temporarily, at any rate, in consequence of the best labour having left the Kalgoorlie mines to work on the Hampton field, working costs have continued to rise, and, but for the premium on gold, it is no longer possible to make a profit on the average grade of the Ivanhoe's ore reserves. A recent cable from the manager states that he does not expect, under existing conditions, to be able to treat more than 15,300 tons per month, and that with this reduced tonnage, prospects are not favourable for the reduction of the total expenses below 31s. 6d. per ton. As the average of the ore reserves is now 33s. 9d. per ton and the loss in residues is about 4s. 2d. per ton, this means that, except for the gold premium, the mine is now working at a loss. In 1919, the quantity of ore crushed was 146,228 tons (as compared with 208,428 tons in 1918), and the yield was 58,155 oz. (as compared with 81,383 oz.), the smallest reported by the company since 1898. Working costs averaged 26s. 2d. per ton, or 3s. 2d. more than for the previous year. The value of the output, including £41,220 from the gold premium, was £291,219 (a reduction of £57,889), and sundry receipts brought the total revenue up to £299,434. The profit for the year was £71,409 (as compared with £79,419), and the dividends 7s. 6d. per share (the same as for 1918). John McDermott, the general manager, estimates the ore reserves at the end of 1919 at 972,387 tons averaging 33s. 9d. per ton, as compared with 1,000,209 tons, averaging 34s. per ton at the end of 1918. Had it not been for the east branch lode opening up so well the reduction would have been considerably more. A schedule of the investments held at December 31 last is given in the report, which shows that the company is interested in British and foreign Government securities, home, colonial, and foreign railways, trust companies, and oil and metal mining companies.

Nundydroog.—This company, belonging to John Taylor & Sons' group of gold mines in the Kolar district, Mysore State, South India, has been producing gold since 1882, and has paid dividends regularly since 1888. The report for the year 1919 shows that 103,529 tons of ore was treated, yielding by amalgamation 77,800 oz. of gold bullion, and that 83,392 tons of tailing and 77,800 tons of accumulated slime gave by cyaniding 8,430 oz. The total gold production was 77,166 oz. fine, which realized £327,043. The working cost was £209,096. Out of the profit, £42,450 was paid as dividend, being at the rate of 15%, £20,186 was paid as royalty, £21,156 was allocated to income tax, and £35,954 was written off for shaft-sinking, etc. The tonnage of ore treated has increased slightly during the last few years, and the yield of gold has remained fairly steady. On the other hand, the costs have increased, so that the divisible profit is now much lower, the dividend being less than one-half of what it was two years ago. The reserve at December 31 was estimated at 184,900 tons, a fall of 17,400 tons as compared with the year before. In Kennedy's section development at the 4,000 ft. level has disclosed ore of good grade, but the ore in the winzes below this level is not so satisfactory. Other work is being done in depth with varying results, and exploration is also being conducted in the upper levels.

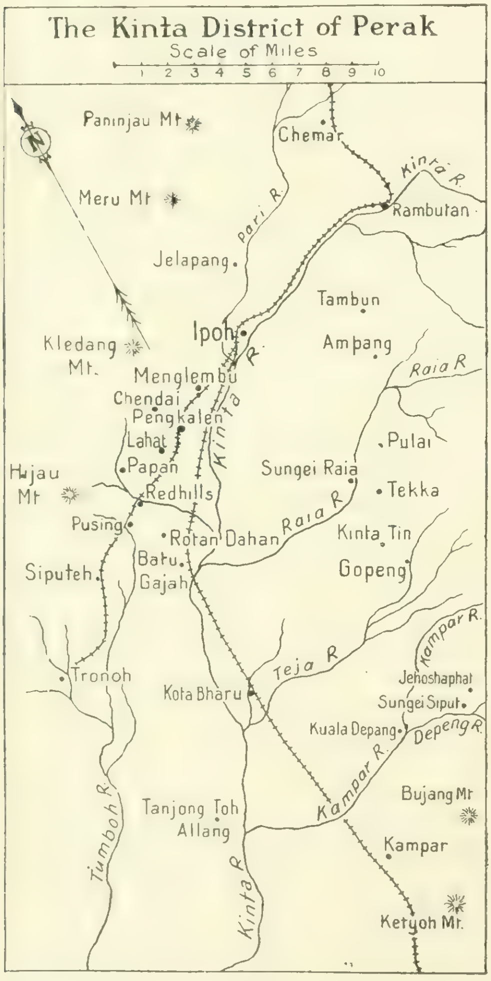
Ooregum Gold Mining.—This Indian gold-mining enterprise, formed in October, 1880, has been a dividend payer for nearly thirty years, and to date has distributed £2,908,652 among the shareholders. Since 1914 there has been a falling off in the returns, the distributions for 1919 totalling £93,173, representing 3s. 3d. per share on the preference and 2s. 3d. per share on the ordinary shares. The directors' report shows that 154,050 tons of ore was crushed for a yield of 90,434 oz. of fine gold which realized £383,439, as against 152,780 tons yielding £380,220 in 1918. Working costs were £12,300 higher on account of high prices for materials, increased wages, and adverse exchange rates. The profit on the past year's operations was £134,477. Income tax absorbed £12,433, and depreciation £32,000. Development operations during 1919 gave "highly satisfactory results." H. M. A. Cooke, the superintendent, reports an increase of 35,276 tons in the ore reserves, estimated at 427,966 tons at the end of December last, in which connection he points out that the re-making of the ore-shoot in Oakley's section has already added much valuable ore, while, in addition, holding out "a most encouraging prospect for the future of the mine in depth." In Bullen's section, he states, the continual presence of the pegmatite intrusion has resulted in much unprofitable work, but at points where the pegmatite has passed out of the line of the reef, the reef is again found and is of excellent width and value. Since his report was written, the directors state, a distinct improvement has occurred in that section of the mine. The question of a suitable plant for re-treating the sands is still having attention, and after some further experiments have been carried out it is hoped that a scheme for the profitable treatment of the tailings will present itself. The company has joined two of the other Indian gold-mining companies in forming the Indian Mines Development Syndicate, with an authorized capital of £20,000, for prospecting mining properties in Burma, and has also recently completed negotiations for securing a grant of a prospecting licence and a lease over extensive mining areas in the State of Kharsawan, India.

Tharsis Sulphur & Copper.—For over fifty years this company has been working copper mines in Spain and it also has metal works at several places in Great Britain. Including the 1919 amount of £103,797, the net profits earned total £10,891,264, and nearly the whole of this has been distributed among the shareholders, the return being equivalent in the aggregate to 956½%, a wonderful record. The quantity of ore raised from the Tharsis and Calanas mines last year was 260,801 tons, a decrease of 67,791 tons compared with the 1918 total. At the metal works the quantity of ore treated was not greatly under that of the previous year. The year's net profit was £22,498 less than the year before, and the dividend of 12½% less tax, absorbing £109,375, contrasts with 10% free of tax, absorbing £125,000 for 1918.

Mason & Barry.—Although the operations of this company, which works the San Domingos mine in Portugal, resulted in a loss of £6,047 last year, the directors have declared a dividend of 2s. per share less tax out of the amount brought forward from 1918, and after allocating £3,000 to the staff pensions fund there remains a balance of £7,327 to be carried forward. The quantity of ore broken and raised at the mine last year was 60,522 tons as against 80,079 tons in 1918, and the shipments, inclusive of ore from the cementation works, amounted to 41,827 tons as compared with 35,490 tons. The stocks of ore and copper precipitate on hand at December 31, 1919, were valued at £93,942, as against £90,307 at end 1918.

South Crofty.—This company operates the South Crofty tin-wolfram-arsenic mine at Carn Brea and a wolfram property at Castle-an-Dinas, Cornwall, both under the management of Josiah Paull. At South Crofty there was milled a slightly larger quantity of ore last year than in 1918 (68,056 tons against 67,588 tons), but in consequence of the decline in metal prices the average value of the output was only 33s. 3d. per ton crushed as compared with 57s. 9d. in the preceding year. The black tin recovered was 545¾ tons (against 581 tons), wolfram 59 tons (against 71 tons), and arsenic 631¾ tons (against 562 tons). The average prices obtained were £140. 2s. 2d. per ton for black tin (or £56. 14s. 6d. less than in 1918) and £52. 11s. 7d. for arsenic (or £53. 2s. 11d. less than before). No wolfram was sold last year. Costs at the mine per ton crushed were 30s., or 4s. 10d. less than in the preceding year. The financial outcome of the year's operations was a net profit of £299, but interim dividends absorbing £10,000 were paid during the twelve months and a final dividend of 6d. per share, free of tax, which will require a further £10,000, has been declared. These distributions come out of the balance of £27,943 from 1918. At South Crofty 3,554 ft. of development work was done last year, as compared with 3,572 ft. in 1918. Mention is made in the development report of 102½ ft. having been driven east of the 225 level cross-cut north on Kellow's lode, the average being 10 lb. tin to the ton. This is on the lode corresponding in position to the Rogers lode in East Pool, the adjoining mine. On Kellow's lode a total distance of 297 ft. has been driven, but as values continued disappointing and there remained only some 280 ft. between the end of the drive and the East Pool boundary, it was decided some months ago to stop this development until such time as the East Pool might extend its development to the boundary. It is proposed to put out a bore-hole during the current year from South Crofty's 290 fm. level cross-cut in further search of the Rogers lode. At the Castle-an-Dinas mine 3,349 tons of ore was treated for a yield of 41 tons of wolfram. Milling was carried on for only eight months out of the twelve, having been suspended early in September last owing to the fall in the price of wolfram which followed the removal of Government control. Development was continued, and in the twelve months 786 ft. was done. The manager estimates the average of the wolfram lode over this distance to be approximately 25 lb. per ton for a width of 3 feet.

Mount Bischoff Tin.—This company has operated tin deposits at Waratah, Tasmania, since 1873. The crude ore output for the half-year ended December 31 was 52,334 tons, which was dealt with by the mill in 143·24 days, or nearly 92% of the possible time, and in the same period the roasting furnace treated 93·8 tons of pyritic concentrates. The dry weight of tin oxide was just over 199 tons of an average grade of 63·74%, and the average extraction of tin from the ore was 0·232%. Working costs per ton of ore, including assaying, surveying, administration, &c., were 8s. 0·685d. The total quantity of tin oxide smelted was 2,260 tons 12 cwt., which yielded 1,527 tons 11 cwt. of tin; that smelted on behalf of the company (and tributer) was 210 tons 8½ cwt., which yielded 126 tons 18 cwt. metal, the remainder being on public account. Since early in the term operations were hindered by industrial troubles which affected the whole Commonwealth, commencing with the seamen's strike. The profits for the half-year were £12,114, from which £7,500 has been distributed in dividends. There was an expenditure on plant and building during the term of £1,167. Since the report was compiled a discovery of rich ore has been made in the brown face on the southern slopes of the property, which, some years ago, was an important contributor to the company's output. The chairman, Dr. L. Gray Thompson, will not commit himself to any estimate of its value; he will merely say that though the existence of the lode has been known for a long time it has only now been cut, almost inadvertently, by a party of contractors in rising. Private reports state that the discovery is a valuable one. A level is to be put into it, but the extent of the formation will not be known, even approximately, for some time.



Gopeng Consolidated.—This F.M.S. alluvial tin-mining proposition did not fare nearly so well in the twelve months ended September 30 last as in the preceding year. Not only was there a falling off in production and in the price of the metal, but costs were appreciably higher. The report of Osborne & Chappel, the general managers, shows that at 1,423,283 the number of cubic yards treated was about half a million less than before, and, although the recovery per cubic yard was slightly higher, the output was 836 tons of tin ore as against 937 tons in 1917-18. The costs of operating were nearly doubled, having been 26·02 cents (7¼d.) as compared with 14·25 cents per cubic yard, while the average price obtained for concentrates was $71·85 per pikul (equal to £140. 16s. 6d. per ton) against $87·74. The reduction of the yardage treated is attributed mainly to the lower levels being worked, and also to the exceptional drought during the last three months of the financial year, when water was very short. Allowing for the loss of £411 incurred on working the Ulu Gopeng property, the accounts for 1918-19 show a profit of £83,779, which contrasts with £135,011 for the previous year. Shareholders have received distributions amounting to 4s. per share which absorbed a total of £79,153.

Pengkalen.—A considerable reduction in profit in the year ended September 30 last was experienced by this company, the amount earned having been £8,878, as compared with £16,973 in 1917–18. Shareholders have received dividends of 12½% on the preference and 2½% on the ordinary shares, as against 15 and 5%, respectively, for the preceding year. The suction-dredge production was only 15·53 tons of concentrate as compared with 97½ tons in the previous period, the dredge having been in operation for only 3 months. The general managers state that a certain amount of ground contiguous to the Kinta river still remains but can be included in the area to be worked by the bucket-dredge when installed. Since the close of the financial year under review the capital of the company has been increased to £200,000 to provide funds for dredging plant to work a new bucket-dredging area which has been acquired recently.

Rambutan.—This member of the Wickett group of F.M.S. tin-mining companies also experienced a falling off in production in its last financial year, while working costs were increased. The general managers' report for the twelve months ended June 30 last shows that the yardage treated was 502,812 (as compared with 505,700), the cost was 22·05 cents (against 16·90 cents) per cubic yard, and the average price realized for concentrates was £6. 17s. 2d. per ton less than before. In the result the working profit from an output of 172 tons (against 242 tons) and including sundry revenue was £16,481 as compared with £29,327 for 1917-18. Dividends amounting to 2s. 8d. per share and absorbing £13,333 have been paid for 1918-19. The directors in their report point out that the opinion expressed by the general managers that "prospects for the current year are more encouraging" has been justified by the monthly output, which is very considerably in excess of that for 1918-19.

Chendai Consolidated.—An output of 28 tons of tin concentrate was won by this company from its mine in the year ended April 30, 1919, the directors' report for which period was issued only towards the end of last month. This production represents a decrease of 9 tons on the year. The general managers' report shows that the mill worked only from May to October, 1918, and that there was a loss on working of £503. From the tribute workings, however, 77 tons of tin concentrate was won, from which the company received £1,804. Of this 77 tons, the Chendai section yielded all except nearly 9 tons, and the major part of the output was obtained from the lode-cap on the north-east side of the hill. The hydraulicking operations were carried down in places to the rock, and the ore-body disclosed, the general managers venture to forecast, "should prove a valuable asset when more development work is carried out."

Kledang.—Still more belated is the report of this unsuccessful enterprise, the document issued on the

22nd ultimo covering the year ended February 28, 1919. Operations resulted in a loss of £535 and debenture interest took £926, making a total loss of £1,461. Since the period under review, the whole of the company's leases have been sub-let to the owners of an adjoining property, who are constructing a pipe-line in order to work the ground hydraulically.

American Smelting & Refining.—This New Jersey company, with a share capital of $115,000,000, owns smelting works and refineries in various parts of U.S.A., Mexico, and Chile; large interests in mines operated to assure ore supplies for the smelters; a controlling interest in the American Smelters Securities Co., and all the capital stock of the United States Zinc Co. The report of the directors for 1919 states that the reconstruction period of 1919 probably affected the smelting and refining of metals as seriously as any business carried on in ordinary times of peace. The immediate result of the Armistice was an almost complete cessation of demand for copper, lead, and zinc. The reduction in mine production (which in the first six months was nearly double that in the last six months) curtailed the operations of the smelters and ultimately the refineries proportionately, and this increased the cost of operation per ton treated. In addition, it was necessary to reduce the force and readjust methods, which also increased the cost of operation. The cessation of demand for the metals locked up the company's liquid capital and compelled a greatly increased metal carry for a considerable period of time. The situation compelled the company, early in the year, to take drastic measures to decrease expenditures to the lowest possible point. The succeeding months showed the beneficial results of the steps taken and marked a turn in earnings, and thereafter showed continuous improvement. The total results, by six months' periods, were as follows: First six months, net income $2,149,159, amount available $24,496; last six months, net income $3,446,425, amount available $1,329,766; total net income for year $5,595,584, amount available $1,354,262. The rising price of silver turned attention particularly to Mexico, and every effort was made to develop the Mexican output to the greatest possible point. Many of the mines were worked throughout the year and their earnings were an important factor in profits, but the company was not able to commence shipments from some of the most important of the mines until early in 1920, and hence the full effect of the year's work in Mexico was not apparent in the outcome for 1919. A substantial interest was purchased in the Premier mine, in British Columbia, and options were taken on several properties in that country. The company also completed the acquisition of over 90% of the Sabinas Coal Company.

Modderfontein B.—The gold premium is estimated to yield this member of the Central Mining-Rand Mines group no less than £151,000 in respect of the last 5½ months of 1919, and the working profit for the whole twelve months is reported as £846,657, or 26s. 1d. per ton milled, while working costs were 22s. 5d. per ton. The net profit is given as £881,036, and dividends amounting to 92½%, absorbing £647,000, have been paid. In 1918, the working costs were 19s. 8d. per ton, the working profit 21s. 9d. per ton, the net profit £685,596, and the dividends 82½%. The report of the consulting engineer, H. Stuart Martin, shows that ore of a higher grade was milled last year, and that apart from the gold premium the increase in working costs exceeded the increase in yield by 4d. per ton. The native labour supply having been better, more development work was done. Of the total footage on reef, namely, 12,800 ft., 1,450 ft. was exposed on the eastern side of the mine, but only a small addition was made to the ore reserve in this section, the area between the 2nd and 3rd levels being unusually faulted and on the whole poor in grade. In the central section only a small amount of work was done. In the south-east corner the 915 ft. sampled averaged 17·2 dwt. over 38 in., the remainder of the distance, 314 ft., being in faulted ground. In the western area, where the greater part of the development was done, this was chiefly for the purpose of splitting up the large blocks between the 3rd and 4th levels. The remaining footage in this area was in new ground where reef disclosures were uniformly good. The quantity of payable ore developed during the year is estimated at 575,000 tons valued at 9·3 dwt. This compares with 755,415 tons mined during the period; consequently ore reserves at the end of 1919, estimated at 3,215,100 tons averaging 9 dwt. per ton, show a falling off. It has been decided to sink an additional south-west shaft in view of the large tonnages that will have to be dealt with from the deeper western side of the mine and of the great distance of this section from both the old central and new south-eastern shafts. The remaining 1,300 ft. of sinking at the south-eastern vertical shaft is expected to be completed about the middle of the current year.

Van Ryn Deep.—At this mine satisfactory progress was made during 1919, according to the figures set out in the annual report. The ore milled increased by 40,000 tons to 570,400 tons, the grade was 0·6s. higher, and although costs increased by almost 1s. per ton, the working profit, with gold at par, was £37,600 larger at £654,754. The premium on gold is estimated to have yielded £132,655. Cash dividends totalling 47½% (against 45% for 1918) have been paid, and in addition shareholders have received a scrip distribution in the form of one New State Areas share for every eight Van Ryn Deep shares held. W. L. White, the consulting engineer, reports that the policy of sweeping and washing stoped-out areas is being actively pursued, and has resulted in a large addition to the revenue, and also in a material lessening in the quantity of ore required from current stoping to keep the mill working at its full capacity. A large amount of development was carried out during the year, with excellent results in the central and eastern portions of the mine, and at the end of December last the ore reserves were estimated at 3,200,000 tons of an average value of 9·1 dwt. over a stoping width of 72 in., as compared with 2,445,759 milling tons, recovery value 9 dwt. per ton, at the end of 1918.

Government Gold Mining Areas (Modderfontein).—Continued expansion is disclosed by the annual report of this company, now one of the chief Rand gold producers, and the one which has the distinction of having the largest tonnage of ore developed ahead of its treatment plant. In 1919 the ore crushed was 1,361,000 tons, or 28,000 tons more than in the preceding year, and the yield per ton was 35·6s. as against 33·1s. Working costs rose from 19·7s. to 21s. The working profit (with gold at par) was £997,017, an increase of nearly £120,700, but the gold premium brought the total up to £1,246,875. The Government's share of profits was £621,342. Shareholders received dividends amounting to 37½% for the year, or 10% more than was paid for 1918. W. L. White, the consulting engineer, reports that development results were very satisfactory. Of the total footage on reef, 17,140 ft. or 64·7% was payable and averaged 17·4 dwt. over 50 in., as compared with 17,230 ft., or 73·6%, averaging 16·1 dwt. over 43 in. in 1918. The ore reserves at the end of December last were estimated af 11,001,700 tons of an average value of 8·6 dwt. over a stoping width of 77 in. These ore reserves are stated to be widely distributed. "The accompanying plan" is referred to by the consulting engineer, but none is issued with the directors' report. This mine also had a bettter supply of native labour during the past year, and the efficiency of the men showed improvement.

Rand Selection Corporation.—This company, which was originally formed as the Transvaal Coal Trust, is closely associated with the Consolidated Mines Selection and the Far East Rand mines which go to form that group, namely, Brakpan, Springs, and West Springs. For 1919 the corporation's profit and loss account shows a credit balance of £146,141. Government taxes absorbed £10,717. In addition to a cash dividend of 10% a distribution was made at the rate of 8 enemy shares per 100 shares held, the value of this dividend being put at £133,270. The unappropriated balance at the end of 1919 was £22,070. During the past year the corporation increased its Brakpan holding to 266,355 shares, its Springs Mines holding to 279,743 shares, and it participated to the extent of 11½% in the guarantee of a loan up to £250,000 for Daggafontein Mines. On the other hand, the corporation's interest in West Springs was reduced to 3,493 fully paid and 100,000 two-shilling paid shares.

Brakpan.—There was a falling off in the tonnage treated at this Far East Rand mine last year, but the gold premium raised the working profit above that earned in 1918. Nevertheless, the dividends for the past year totalled 27½% as against 32½%. The decrease of 72,900 tons in the quantity of ore milled is attributed by Carl R. Davis, who has succeeded C. E. Knecht as consulting engineer, to the southern, or lower, section of the mine having contributed less than its normal amount, due to difficult roof conditions in some of the stopes being further aggravated by the enforced use of machines for stoping. The yield per ton was 2s. 10·47d. higher, but this was more than offset by an increase of 3s. 2·11d. in working costs. The yield (38s. 2·37d. per ton) was higher than called for by the value of the reserves, and a portion of the excess gold was carried to reserve, namely, 3,724 oz. At the end of December last the ore reserve was estimated at 2,484,000 tons averaging 8·74 dwt. over a width of 70 in. These figures compare with 2,718,000 tons, averaging 8·7 dwt. over 68 in. at the end of 1918. The net balance of expenditure over revenue last year was £424,246. Government taxes and participation in profits, dividends, &c., absorbed £342,115.

Springs Mines.—This Far East Rand mining company, belonging to the Consolidated Mines Selection group, dropped out of the dividend list last year, the directors deciding that it was in the best interests of the company to appropriate from profits a sum sufficient to meet the excess expenditure on the original equipment of the property, and provide for standard stock of stores and materials and shares and interests in other companies. This involved the sum of £379,274. In 1919 the quantity of ore milled was 434,610 tons, an increase of 7,000 tons, the revenue per ton 38s. 2·41d. (against 42s. 4·37d.), the working cost per ton 26s. 9·14 d. (against 22s. 6·57d.), and the working profit per ton 11s. 5·27d. (against 19s. 9·8d.). But the working profit of £248,573 (against £423,696) was increased to £343,665 by the premium on gold and adjustments in respect of realization charges. Expectations as to working costs for the present year are necessarily on the high side, owing to increases in the wage scale for both European and coloured employees and the continued increase in the cost of stores. At the end of December last the ore reserve was estimated at 2,417,298 tons, averaging 8·74 dwt. over 62·92 in. These figures compare with 2,367,636 tons, averaging 9·26 dwt. over 61·25 in. at the end of 1918. Carl R. Davis, who has succeeded C. E. Knecht as consulting engineer, reports that a comprehensive scheme has been adopted for the future development of the property. No. 3 shaft is expected to reach the reef about the middle of this year, and it is hoped to have everything in readiness for sinking No. 4 shaft on the completion of No. 3 shaft.

West Springs.—This Transvaal company, which was formed in June, 1918, to acquire a Government lease of the mineral rights over 2,235 claims immediately to the west of Springs Mines, is still at the shaft-sinking stage. The report for 1919 shows that No. 1 shaft had been sunk 982 ft. to the end of the year, and the No. 2 shaft 591 ft. Development work in West Springs area carried out from Springs Mines during the twelve months amounted to 780 ft. The footage sampled in the period was 815 ft., and the results were: reef width 20·81 in., assay-value 11·05 dwt. The capital at the end of 1919 was £531,978, comprised of 435,532 shares of £1 fully paid, and 964,468 shares 2s. paid. Cash and cash assets (after deducting sundry creditors, etc.), amounted at the same date to £178,117.

Daggafontein.—This member of the Consolidated Mines Selection group is still at the developing stage, and the report for 1919 shows that it was necessary to provide further funds. The Consolidated Mines Selection Co. undertook to guarantee the funds required until June 30, 1920, up to a total of £250,000, and at December 31 last the loan had been drawn on to the extent of £90,900. Carl R. Davis, the consulting engineer, reports that during the year under review the pumping plant at No. 1 shaft was completed and the ventilation of the mine workings has been put on a sound basis. At No. 2 shaft 1,941 ft. were sunk, making the total depth 2,969 ft. It is expected that the reef may be cut at a depth of about 3,900 ft.

New Kleinfontein.—This member of the Anglo-French group of Rand mines would have had to report a loss on the past year's working if it had not been for the gold premium. This yielded the company £112,131 and the working profit was £103,095. Taxes and interest absorbed £10,723, and the following appropriations were made: shaft-sinking £18,470, machinery, plant, &c., £27,622, reserve for repayment of capital loans £15,000. No dividend has been paid for the last two years. In 1919 the ore milled, at 630,020 tons, was 44,720 tons less than in the previous year, but working costs were 2s. 2d. higher at 26s. 2·8d. per ton. E. J. Way, the consulting engineer, states that part of the increased cost is accounted for by the poor efficiency of the underground white worker offering himself for employment, and to the fact that very many of the best men have been obliged to give up work owing to the operations of the Phthisis Act. The ore reserves at December 31 last, calculated on the same basis as a year earlier, were estimated at 2,312,000 tons, averaging 5·53 dwt. over 58 in., as compared with 2,048,000 tons, averaging 5·78 dwt. over 59 in. at the end of 1918. The outstanding features of the past year's development work are reported to be the discovery of high-grade ore in the Orient section of the old mine and the disappointing results in the Apex section. The western reduction plant was closed down at the end of July, and all ore has since been treated at the eastern plant.

Witwatersrand Gold.—Unlike some of its younger and stronger companions of the Barnato group, this company (better known as "Knights") was severely handicapped last year by native labour shortage. The average supply was only 69·25% of the underground complement allowed. The quantity of ore crushed at 397,300 tons was 31,600 less than in 1918, while costs were 2s. 4d. per ton higher. With the premium on gold, estimated at £48,386, the working profit for 1919 was £89,376 as compared with £83,882 (without any gold premium) for 1918. The past year's dividends amounted to 10% and absorbed £46,962, whereas 15% was paid for the preceding twelvemonth. W. L. White, the consulting engineer, reports that development in the lower part of the mine has been somewhat disappointing. The ore reserves—1,142,500 tons averaging 5·9 dwt. over 72 in.—show a small decline in quantity and value.

Witwatersrand Deep.—Although this company, the control of which passed from the Central Mining-Rand Mines group about a year ago, made a profit in 1919 as against a loss in 1918, no dividend has been paid to the shareholders since the 5% distributed in respect of 1917. In 1919, the quantity of ore milled was 348,870 tons, or 28,280 tons less than in the preceding year, the reduction being due partly to the temporary cessation of operations in the northern section, which was decided on because the existing layout prevented economical handling of rock. The gold yield was 97,946 oz., equal to 5·6 dwt. per ton, and including £44,370 derived from the gold premium, the revenue amounted to £458,394, or £22,791 more than in 1918. Working expenditure, however, amounted to £435,480, or 25s. per ton, an increase of 1s. per ton, leaving a working profit of £22,914. 1s. 3d. per ton. The net profit was £19,082, which compares with a loss of £16,436 for 1918. At the end of December last the ore reserves, including shaft pillars, were estimated at 922,639 tons, or 31,026 tons less than a year earlier, but the average value is now given as 6·4 dwt. as against 5·9 dwt. per ton. The directors devote considerable space in their report to an account of the troubles they have had to face, and they observe: "Grave difficulties have been overcome, and though others are in sight they are not such as to disturb confidence in the mine's progressing payability in 1920 and the following years." D. T. Morton is manager.

New Primrose.—The gold premium enabled this old stager to rejoin the list of Rand dividend-payers last year, distributions amounting to 10% being made. The working profit was £41,379 (of which the gold premium accounted for £21,935) from the treatment of 210,900 tons of ore, which yielded 48,327 oz. of gold. Rather more than half the tonnage milled was derived from reclamation work, and the manager, H. L. Krause, writes that from all available information a continued supply from this source is assured for some time to come. At the end of 1919 the ore reserves were estimated at 45,400 stoping tons, assaying 6·4 dwt. over 53 in., and the consulting engineer, W. L. White, reports that there remains an area of about 30 claims to be developed.

City and Suburban.—This company, formed in Natal in 1887, is one of the Rand's old stagers with a fine dividend record, and its property and plant are now about to pass to its younger neighbour, the City Deep. A cable received a few weeks ago announced that a provisional agreement had been arrived at for the sale for 45,000 City Deep shares. This price, however, does not cover the company's township, stores, cash, and the gold remaining in the plant. The report for 1919 shows that the quantity of ore milled further dwindled to 220,068 tons and the yield (with gold at par) to £343,171, a decrease of £73,700 compared with the 1918 total. Working costs, on the other hand, increased from £369,516, or 29s. 8d. per ton, to £380,187, or 34s. 6d. per ton, so that there was a loss on working of £37,016. The premium on gold was estimated to amount to £34,695, which would reduce the operating loss to £2,300. Percy Cazalet, the consulting engineer, states that the prime cause of the year's unfavourable results was the trouble experienced with the incline shaft. During each month from January to August movements of the strata caused some damage to the shaft and necessitated the stoppage of hoisting from the lower levels, on occasions for as much as a week at a time. This shaft trouble was three-fold in its effect; it reduced the tonnage milled, cut off the high-grade area of the mine, and necessitated heavy expenditure on shaft maintenance. Labour shortage and the continued increase in wages and the cost of stores were also contributory factors. A table in the report sets out the block ground developed in the mine of an estimated value of 5 dwt. and over, all of which would give a profit under favourable conditions. The total is 209,100 tons of Main Reef Leader, averaging 7·9 dwt., and 79,700 tons of South Reef, averaging 7·3 dwt. In addition, there are 63,000 tons in boundary pillars and isolated blocks at present unavailable; a considerable tonnage of Main Reef developed, of which it is estimated that 233,000 tons average 5·2 dwt.; and in the south-east corner and along the southern boundary of the mine there remains an undeveloped area in which the payable tonnage is estimated at 80,000 tons averaging 9 dwt. The current year's results are likely to be seriously affected by the fall of hanging wall which occurred in the shaft in January.

New Heriot.—At this company's mine on the Rand crushing has been in progress now for 32 years, and the payment of a long series of dividends was commenced in 1889, but since 1917 no distribution has been made. The report for 1919 shows that there was a further decline in the tonnage milled to 134,390 tons and the yield, taking gold at par, was about £9,700 down at £180,041. The gold premium, however, was expected to give £16,612, and so turn a working loss into a profit of £5,976. The development of the mine is practically completed with the exception of prospecting in certain low-grade areas and a small amount of winzing on the Main Reef Leader. The consulting engineer, Percy Cazalet, writes that the mine has now reached a stage of its life where the estimation of the ore reserves is a matter of considerable difficulty. Fluctuations in working costs which must be expected at this time, coupled with the uncertain premium on the value of gold, make it impossible to determine a pay limit which will correspond to actual working conditions for any length of time. He gives a table showing the tonnage and value of the ore developed and immediately available from 4·5 dwt. up to 8 dwt. and over, all of which, he states, might, under favourable circumstances, be expected to yield favourable results. The total is 167,580 tons, and the average value 6·6 dwt. over an average stope width of 48 in. In addition, there are estimated to be 14,500 tons in boundary pillars, 19,000 tons in areas still undeveloped, 39,500 tons in stope pillars and small isolated blocks of ground, and, besides, a certain amount of reclamation ore is expected to be found. The prospects for the current year are described as uncertain. Under the policy of concentration it has been possible to effect drastic retrenchment, but the grade of ore obtained has not responded to the concentration of work on the remaining richer areas, with the result that there is now little margin between revenue and working costs, and any additional burdens must result in monthly losses.

Randfontein Central.—Five years, all but a few months, have elapsed since this big Western Rand consolidation declared a dividend. The company has declared working profits, but these have been required to meet debenture interest and redemption, and a large sum has had to be borrowed from the Randfontein Estates. At the end of 1919 this loan amounted to £698,000. Last year at the Randfontein Central operations were hindered by shortage of native labour, and the financial results were not up to expectation, chiefly on account of the increased cost of labour and material, while the cost of shaft maintenance was heavy. Ore milled amounted to 1,729,400 tons (as compared with 1,745,900 tons in 1918) and 468,595 oz. of gold were recovered, the average yield being 5·419 dwt. and the assay value of the residues 0·300 dwt. The actual extraction was 94·543%. With the estimated premium on gold, £218,582, the total receipts from gold were £2,215,695 and the working expenditure £1,906,606, leaving a working profit of £309,089 (as against £108,072 for 1918). Debenture and other interest absorbed £164,095. Debenture redemption took £109,100, and £70,419 was appropriated towards capital expenditure in addition to £141,384 expended on capital account. W. L. White, the consulting engineer, reports good progress with the sinking of the new vertical shafts. The north vertical shaft is to be stopped at approximately 4,000 ft., but the south vertical is to be continued to the full depth of 5,000 ft. In the north vertical shaft the Leader & West Reefs were intersected at the latter end of the past year at 3,210 ft. and 3,560 ft. respectively, the assay-value reported in each case being 9·8 dwt. over 48 inches. Two of the permanent electric winders, one for the north and the other for the south vertical shaft, have been ordered and it is expected that these hoists will be put to work during the first half of 1921. The ore reserves at the end of 1919 were estimated at 3,802,000 tons of 6·3 dwt. over 49 inches (including about 250,000 tons not immediately available). At the end of 1918 the total was 4,254,000 tons of 6·8 dwt. value.

Consolidated Langlaagte.—This member of the Barnato group was able to crush 4,500 tons more ore last year than in 1918, but working costs were about 1s. 6d. per ton higher owing to increases in the cost of stores, to heavy contributions under the Miners' Phthisis Act, and to higher war bonuses paid to employees. The directors' report shows that the gold premium yielded £65,658, and the total revenue from gold was £706,071, the working profit for the year being £185,155, as compared with £159,232 for 1918. The dividends—12½% against 5% for 1918—absorbed £118,750. At the end of December last the ore reserves were estimated at 2,090,300 stoping tons of an average value of 6·25 dwt. over 55 in., as compared with 2,103,000 tons averaging 6·2 dwt. a year earlier. W. L. White, the consulting engineer, reports that the amount of development work done last year was 2,431 ft. more than that accomplished in the preceding period. The South Reef shows signs of becoming poorer in depth, but some good values were met with on the Main Reef Leader. The mine's native labour force averaged approximately 7% higher than in 1918.

Langlaagte Estate & Gold.—The control of this company passed from the Robinson to the Barnato group a few years ago. In 1919, according to the directors' report, the quantity of ore milled, at 475,480 tons, was 58,210 tons less than that crushed in the preceding year, shortage of native labour being given as the chief reason for this decline. Working costs at 21·1s. were 2·1s. per ton higher. Including the gold premium, estimated at £58,074, the working profit for 1919 totalled £146,789 as against £139,083, without gold premium, for 1918. The dividends for the past year were 15%, absorbing £132,975 or 2½% more than shareholders received for 1918. W. L. White, the consulting engineer, reports that, with a view to placing the mine in a better state of development, shaft-sinking is now being pushed forward as rapidly as possible. Although not so high as during the previous year, the development results are stated to have been satisfactory. The latest ore reserves estimate, however, gives 1,002,400 tons of an average value of 6·5 dwt. over a stoping width of 52 in., as against 1,036,200 tons averaging 6·9 dwt. at the end of 1918.

New Unified.—The gold premium yielded this company £14,930 last year, and the total working profit was £36,338, which compares with £27,880 for 1918. Dividends of 10% were again paid. The ore milled was 141,400 tons, or about 9,000 tons less than in 1918, and the gold yield was 32,293 oz. W. L. White, the consulting engineer, reports that practically no development remains to be done on this mine, and the latest estimate of the payable reserves gives 149,000 tons, averaging 6·5 dwt. over 47 in., a reduction of 31,840 tons compared with the figures at the end of 1918.

Premier (Transvaal) Diamond Mining.—Record financial results are disclosed by this company's report for the year ended October 31 last, although the number of loads washed showed a further decline at 4,529,261, which total compares with the high level of 10,434,680 loads washed in 1912-13. The number of carats found was also smaller last year at 814,577, which compares with 2,145,832 in 1910, but the value per carat jumped to 48s. 1·84d., an increase of nearly 20s. on the year. Production costs were 8d. higher at 2s. 10·68d. per load. The year's working profit amounted to £1,306,710. Out of the company's 40% share of the profits, dividends were paid amounting to £432,500, the preference shareholders receiving £92,500, and the deferred shareholders £340,000, the latter sum being equivalent to 850%, which compares with 400% for 1917-18. South African income tax absorbed £24,696, and the Union Government 7½% dividend tax £34,985. D. McHardy, the general manager, attributes the decline in production to labour shortage. In the first five months of the period there was a serious depletion of the native labour force owing to the influenza epidemic. Development was curtailed for a like reason, but there are stated to be 32,500,000 loads of blue ground available above the present lowest level. The average depth of the mine at October 31 last was 275 ft., an increase of 13 ft. on the year. The main incline into the mine has been extended to the 360 ft. level, where another onsetting station has been established. This will facilitate hauling operations and enable the present system to be continued, without further alteration, for at least five years. The angle of dip of the bar of floating reef, which at one time indicated a somewhat serious encroachment upon the working area in the northern part of the mine as the depth increased, has changed entirely, recent development operations in that vicinity disclosing the satisfactory feature that the rock between the 260 ft. and 410 ft. levels is practically perpendicular and that the intrusive mass at the depth so far attained is less formidable than was originally anticipated. Orders have been placed in Europe for all the machinery necessary to re-equip No. 4 crushing and washing plant and to replace the parts withdrawn during the period of the war for the maintenance of the plant at present in commission. In view of the time required by manufacturers oversea to effect delivery, however, it is improbable that the No. 4 gear will be available for duty within the next twelve months.

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CONTENTS.

EDITORIAL

WITH the July issue the price of the Magazine will be raised to 1s. 6d. per copy, and the yearly subscription will be 16s. post free to any part of the world; hitherto the subscription rate has been 12s. in the United Kingdom and Canada and 16s. elsewhere. This increase has, of course, been rendered necessary by the continued rise in the cost of printing and paper. Unfortunately costs are likely to advance still further, and, in addition, it is quite possible that postal rates on printed matter will be put up when the Universal Postal Congress meets in October. Whether the price of, and subscription to, the Magazine will have to be raised again at the end of the current year remains to be seen.

IT is proposed to erect a memorial to the students of the Camborne School of Mines fallen in the war. Subscriptions to the fund may be sent to Mr. T. Knowles, at the School. We take this opportunity to mention that the Annual School Dinner will be held on July 2, at the Commercial Hotel, Camborne.

SO many interesting papers have been read at the meetings of the Institution of Mining and Metallurgy during the session now concluded that it is invidious to make distinctions. Nevertheless it may be said that the paper read last month by Mr. Gilbert Rigg on recent metallurgical practice at Port Pirie was not the least interesting of the series. Seeing, however, that the subject matter of Mr. Rigg's paper was given in the issues of the Magazine for June, 1918, and February, 1920, it is not necessary for us to reprint the paper. At the meeting there was some interesting discussion by Messrs. S. J. Speak, H. F. Collins, and J. C. Moulden, Mr. Speak giving some of his experience in connection with the smelting of the complex lead-zinc ores at the Rhodesia Broken Hill.

ELSEWHERE in this issue will be found an article by Mr. Frank M. Lush on the geology of the Nigerian tinfields. Mr. Lush is a graduate of the Ballarat School of Mines and has been extensively engaged in the treatment of Australian tin gravels. It is natural that he should compare New South Wales with Nigeria, and apply his experience in one country to the other. In all probability, many of our readers will dissent from his views as to the applications of pump and bucket dredges in Nigeria, and we therefore invite a discussion on the subject from those who have made it a special study. As regards the relative advantages of the pump and bucket dredge, and their application in Cornwall, Australia, and the Malay Peninsula, this question was treated in detail in our issues of July, 1912, July, 1913, and January, March, and July, 1917, and it is not necessary for us to recapitulate now. It is rather the value of either or both in Nigeria that is now under the fire of criticism.

UNIVERSITIES and colleges throughout the kingdom are making appeals for funds to extend their spheres of operations, and in every case are meeting with scant response. With huge income-tax and excess profits duty to pay, with a war levy in prospect, and with capital for financing extensions in business worth much less than formerly, it is not surprising that men with money have turned a deaf ear to the appeals. It is true that London University has been offered by the Government a free site in Bloomsbury, but if it accepts the proposal it will have itself to find the money for buildings and endowment. We know of the man who asked for bread and received a stone. The University will not even get a stone; nothing but an area.

COMPETITION for the world's shaft-sinking record is keen among makers of rock-drills and contractors. This keenness has received, shall we say, a further "spur" by the offering by the *Engineering & Mining Journal* of a gold medal to the sinking crew who beats the present record of 310 ft. in 31 days. This record is held by Holman Brothers, and was created in July last year when sinking No. 15 circular shaft at Crown Mines, Johannesburg. The diameter of the shaft as broken was 21½ ft., the debris was hoisted from a minimum depth of 2,000 ft., and the rock broken was hard Rand quartzite. The present record in the United States is held by the Waugh drill, for sinking 308·2 ft. in 31 days, from a depth of 755·6 ft. to 1,063 ft., at the Van Dyke copper mine, Miami, Arizona. We do not know the exact nature of the rock, but it is said to be of the hardest. The *Journal's* action in offering a gold medal for competition is to be commended, for thereby the conditions under which the sinking is done will be properly investigated and the relative merits of the performances carefully weighed. The two records before-mentioned are properly authenticated cases, but, on the other hand, many claims for records have not been so acceptable, owing to the work having been done in much softer rocks. Also the efficiency of the workers is an important item in the relative merits of the results. This point is strongly emphasized by the terms of the *Journal's* offer; it is the crew that gets the medal, and not the drill. It is obvious that the best drill in the world will not prove its efficiency unless capably and enthusiastically handled.

DR. G. P. PEREZ, of Alicante, Spain, claims, in British Patent 11,868 of 1919, to be able to convert mercury into gold, by exposing it in a Crookes tube to Herzian waves. He states that these waves remove sulphurous anhydride from the mercury, with the result that pure gold remains; also that radio-active substances may be extracted from the sulphurous anhydride. In problems relating to the transmutation of metals one has to tread warily nowadays, seeing that modern chemists have shown that radium gives off helium and degenerates into something looking like lead. All we can do is to call upon Dr. Perez to produce some definite evidence that anything of the kind he mentions really happens.

The Status of the Profession.

The annual dinners of the old students of the Royal School of Mines are not merely pleasant social functions; they also provide opportunities for voicing the aspirations of the mining engineer and metallurgist, and for demonstrating the opinions of the profession with regard to the development of mining education. At the dinner last month, the president, Mr. Ernest R. Woakes, had a good deal to say on both of these topics. In the first place, he had the gratifying duty of announcing that the Bill introduced in Parliament by the Institution of Civil Engineers for the registration of engineers had been withdrawn. Readers of the Magazine are aware that the Council of the Civils promoted this Bill for the purpose of preventing unqualified people from practising the profession. This was a laudable ambition, but, like most generalizations, it bristled with difficulties, and raised strenuous opposition. Mining engineers unanimously resented the scheme, for they did not choose that their qualifications should be judged by railway and harbour engineers. They were not alone in their opposition to the Bill, for every other group of engineers outside the favoured ring of the Civils raised serious objections, and opposition arose even among certain groups of members of the Institution itself. Thus the unfairness and absurdity of the position became apparent, and there was no alternative but to withdraw the Bill. As Mr. Woakes said, it is desirable that eventually some scheme should be formulated whereby the engineering profession may be regularized and protected. Such a scheme, however, will only emerge from the present confusion when the Institution of Civil Engineers takes a more gracious attitude toward the other societies. It may be mentioned here that similar steps for the tightening of the engineering profession are proposed in other countries, notably in the United States and British Columbia, but acceptable terms appear to be difficult to arrange. There is another point in connection with the status of the profession to which we may conveniently refer here, though it was not discussed at the old students' dinner. This is the confusion of qualifications in any society arising from the wide scope of membership. In the March issue we mentioned that membership of the Institution of Mining and Metallurgy does not differentiate between mining engineering, metallurgy, and geology, with the consequence that a metallurgical member is often asked to report on the geology of an oil occurrence, or an expert in underground work on the application of powdered coal in reverberatory furnaces. In another part of this issue, Mr. F. P. Mennell reverts to this matter, his point being that geologists without experience in mining should not be eligible for election to the membership of the Institution of Mining and Metallurgy. This, of course, is a debatable question. Mr. Mennell is, perhaps, technically correct, but there are other points of view. For instance, the mining profession may feel gratified (or is the right word "arrided"?) that University professors are taking an active interest in economic geology. Moreover, a theoretical geologist can be of great service to a mining company in mapping the stratigraphy of a district, while the value of the services of a scientific petrologist is obvious. Nor is it likely that men of this position and training would misuse their membership by claiming too wide a range of qualification.

The other subject to which Mr. Woakes referred in his speech was the future of the diploma of the Associateship of the Royal School of Mines and the status of the Imperial

College of Science and Technology. According to his information, the result of the present negotiations within the College appeared to be that the "A.R.S.M." would not be abolished, but that it would be granted concurrently with the B.Sc., whenever the power of granting degrees is obtained. This is probably the best solution of the difficulty. People in the profession will continue to judge a man's qualifications by the ancient and honourable letters, while outsiders who have no specific knowledge of mining education will rely on the University degree. It is not yet clear, however, that the Government educational authorities have agreed to the Imperial College being constituted as an independent University, or whether they will not refer the matter back once more with a renewed proposal to join London University. The leaders of thought and action in the Imperial College desire its conversion into an independent University. On the other hand, almost everybody else, including ourselves, would like to see the College an integral part of London University. The question is still unsettled, and its public discussion continues.

The Wave-Transmission Rock-Drill.

In March, three years ago, we made brief reference to a new type of rock-drill, in which the rapid hammer blows are obtained by a system of wave-transmission through water. This principle is the invention of the Roumanian engineer, Mr. G. Constantinesco, who won fame during the war in connection with his synchronizing apparatus for discharging bullets between the blades of aeroplane propellers. The application of the principle in practice and the development of a series of practical wave-transmission tools is the work of Messrs. W. H. Dorman & Co., Ltd., of Stafford, who hold an exclusive licence to make and sell. It may be here interpolated that this firm were the makers of the aeroplane apparatus mentioned. The rock-drill, as now perfected, is to be seen working successfully at Messrs. Dorman's works. It has got past the theoretical stage, and the many difficulties cropping up when a new principle is first applied in practice have been overcome. We have spent a day examining the drill and testing its performance, and are satisfied that it has arrived at that stage when it can to advantage be tried under working conditions underground. We hope before long to give a complete illustrated description of the drill. In the meantime something may be said with regard to the principle of carrying energy through liquid. Water is slightly compressible under high pressure, and when this pressure is exerted momentarily a wave of compression passes through the water extremely rapidly. If water is confined under pressure in a pipe-line and at one end a rapidly oscillating piston gives a series of compressive blows to the water, the waves of compression pass along the pipe-line and give a series of sharp blows to any obstacle, such as a second piston at the other end of the pipe-line. By a suitable arrangement a reflected wave can be made to impart to the reverse side of the second piston a gentler blow, causing retrogressive motion. If this piston is caused to hit a drill-steel, the apparatus at once becomes a hammer-drill. In the plant as now designed the static pressure in the pipe-line is 100 lb. per square inch, the pressure of the wave is 1,500 lb. per square inch, and the drill receives 40 blows per second. The piston generating the wave is part of a hydraulic machine, which is conveniently driven by electricity or other high-speed prime mover. In the drill the wave is employed also to give a rotating motion to the steel. The steels are hollow, and the water passes down them, with the result that the rock-dust is converted into sludge. Of course, nowadays most compressed-air drills have hollow steels through which dust-allaying water passes, but it is well known that complete allaying of dust is not attained owing to the presence of a constant pressure of air. In the wave-transmission drill no air, only water, is used. It seems to us that this certain prevention of dust is one of the most important features of the new drill, and that, for this reason, its merits should be investigated by those who have the miners' phthisis problem continually before them. The drill also has the advantage of being extremely simple in construction, and seeing that it has no valves or mechanical springs, the demand for "spares" will be small. Exact fit of the working parts is not so necessary as is the case with compressed air, so that wear does not bring down the efficiency rapidly. Tests have shown the power consumed to be less than when compressed air is employed. As regards the arrangement of the installation, in all probability the best plan in a big mine will be to carry the power down the shaft by electric current to portable wave-generating pumps, and to connect groups of, say, four to ten drills to each generator. Finally, it may be mentioned that the application of this principle is not confined to rock-drills; it is equally applicable to riveting machines and caulking tools.

Metal Quotations.

In the May issue some particulars were given relating to the quotations of metal prices and to the control of the trade by the Metal Exchange. These remarks were of a general character and perhaps more humorous than business-like. We revert to the subject this month in more serious mood in order to give some details of the procedure in carrying out contracts under the Metal Exchange regime. These details will no doubt be of use to those new to the trade in metals.

Firstly, as regards copper, we have already said that copper deliverable under a Standard Copper contract must be of the brands and descriptions specified in the Official List of the Metal Exchange, at the time when the contract matures. Under a Standard Copper contract, refined copper, electrolytic copper, and rough copper may be delivered. The unit of dealing is a "warrant," which represents 25 tons, and sellers may deliver each 25 tons that they may sell, either in: (1) Refined copper (assaying not less than 99% and below 99·30%), which is delivered at the contract price; (2) refined copper (assaying not less than 99·30% and below 99·80%) and tough cake, with certificate of quality as provided for in the rules, which are delivered at 10s. per ton over the contract price; (3) refined copper (assaying not less than 99·80%) which is delivered at 20s. per ton over the contract price; (4) rough copper, which is subject to a rebate of 30s. per ton from the contract price, as provided for in the rules. The copper delivered against a standard copper warrant must at the time of delivery be stored in one of the official warehouses or wharves appointed for the purpose by the Committee of the Metal Exchange. These wharves and warehouses are situated in London, Liverpool, Birkenhead, Birmingham, Newcastle - on - Tyne, and Swansea. Where refined copper other than tough cake is delivered by the seller against a Standard Copper contract, the warrants shall be accompanied by a certificate stating the produce, which shall in no case be less than 99%. Where tough cake is delivered against a Standard Copper contract, it must be accompanied by a certificate that the copper is of good merchantable quality, and fit for rolling. The cakes must not weigh less than 1 cwt. or more than 2 cwt. each. As regards rough copper, the standard of produce is 97%, but no excess is paid for by the buyer. A pro rata allowance, based upon the official "settlement" price, comes into force for deficient produces below 97%, and a double pro rata allowance on the same basis for deficient produces below 96%, down to and including 94%. Rough copper assaying below 94% is not good delivery against a Standard Copper contract. All certificates for rough copper must state that the quality has been passed by the assayers as "good merchantable." Standard Copper must be delivered as far as possible in warrants of 25 tons each, and each parcel of 25 tons, whether rough or refined, must be of the same form and class, and must be in one of the official wharves or warehouses. If the warrants be tendered against a contract for a multiple of 25 tons, they must be capable of sub-division into parcels of 25 tons each. Certificates of assay or quality, in the forms settled by the committee of the Metal Exchange, must be attached to all warrants deliverable under a Standard Copper contract, and the certificates may be those only of experts, assayers, or analysts approved by the committee. The sampling of refined copper is made at the public warehouses by drilling one piece for every 5 tons, in the case of tough cake one piece in every 5 tons being taken for testing as prescribed, and in the case of rough copper by drilling sufficient pieces to constitute not less than 10% of the weight of the parcel, each brand being sampled and assayed or tested separately. In the case of refined copper, one sample only is drawn from the drillings, and the contents determined by a public assayer. For rough copper three samples are taken from the drillings and one piece of each is sent to two public assayers, who must agree the produce. If they are unable to agree, the third sample is sent to a third public assayer chosen by the other two, whose report is final and binding. The entire cost of sampling, assaying, and testing is borne by the sellers. The assaying both of refined and rough copper is in all cases done by the wet method.

As regards Standard Tin, the metal deliverable under the Standard Tin contract must, as in the case of copper, be of the brands and descriptions contained in the official list of the Metal Exchange on the day when delivery is due, the official list of brands and descriptions being open for inspection on application to the secretary of the Exchange. Standard Tin is dealt in in units of 5 tons, which quantity represents one warrant. The tin must be at the time of delivery stored in one of the official wharves or warehouses sanctioned by the committee of the Metal Exchange, these wharves and warehouses being situated in London, Liverpool, Birkenhead, and Swansea. The seller of Standard Tin has the option to deliver each 5 tons either in: Straits, Australian, Banka, Billiton, or English refined tin, of good merchantable quality, at the contract price; other refined tin of good merchantable quality, assaying not less than 99·75%, at the contract price; or common tin in ingots or slabs of good merchantable quality, assaying not less than 99%, subject to a rebate of £7 per ton from the contract price. Each parcel of 5 tons delivered under a Standard contract must be of the same description and class, and must lie in one warehouse of wharf; and warrants tendered against a contract for a multiple of 5 tons must be capable of subdivision into parcels of 5 tons each. All warrants for refined tin and for common ingot and slab tin must be accompanied by a certificate stating the produce and proving that the tin is of good merchantable quality; and such certificates must be those only of the assayers or analysts approved by the committee of the Metal Exchange. Warrants for English common tin are a valid tender, even without certificates of assay or quality, but the buyers need only pay a sum on account, and the balance on production of the certificates, which must be delivered within seven days of the date of the warrant.

Metal Exchange dealings in lead are on the basis of "Good Soft Pig Lead" delivered ex ship or ex wharf, free into craft Thames, in one or more parcels of not less than 50 tons each, each delivery being treated as a separate contract. Under the lead contract, shipment lead is sold, the month being specified in the contract during which shipment has to be made. The seller may fulfil the contract by making delivery ex wharf not earlier than the 10th day of the month named for shipment and not later than the 9th day of the following month, but the steamer's name must be declared not later than two market days before the 9th day of the month following that specified for shipment. No declaration is valid in the case of a steamer delayed by collision, strike, or accident, unless such declaration is made before news reaches England of such delay. Should the whole or any portion of the lead for which the vessel's name has been declared to the buyer against the Metal Exchange lead contract be lost on the voyage, and not come forward by any other vessel or vessels on the seller's account, the contract for the lead so lost is void. Shipment is understood to mean by steamer due to arrive in London between the 10th day of the month named and the 9th day of the following month, but lead actually on board a steamer and shipped from a port in Spain, the Mediterranean, or the east coast of the United States of America during the month named is a good delivery, irrespective of the date of arrival. Unless otherwise provided, all lead delivered ex ship is to be weighed at the buyer's works and at the buyer's expense, the sellers having the option of seeing the parcel reweighed, but paying the cost of the reweighing if the original weight is practically confirmed. Lead ex wharf is to be weighed on delivery ex wharf, except in the event of warrant lead being delivered from a public warehouse, in which case the warrant weight is to be accepted. An allowance of 6d. per ton is made to the buyer in any case where the pigs weigh more than $1\frac{1}{2}$ cwt. each. There is no official list of brands, and no official regulations in connection with sampling and assaying.

The Metal Exchange spelter contract covers "virgin spelter" of good merchantable quality, delivered ex ship or ex wharf free into craft Thames, free ex warehouse or ex quay Liverpool, or free on rail Swansea, in the seller's option, in one or more parcels of not less than 25 tons each, each delivery being treated as a separate contract. As with lead, the spelter is sold for shipment during a named month, such shipment being understood to mean by a steamer due to arrive within the month named, or on or before the 5th of the month following the month named; but spelter actually on board a steamer and shipped from a port in Europe or the east coast of the United States within the month named is a good delivery, irrespective of the arrival date. In the case of shipments made from other countries, the declaration is good, irrespective of the date of shipment, provided the steamer is due to arrive not later than the end of the month named for shipment. The seller may fulfil his contract by making delivery ex wharf, free into craft Thames, or ex warehouse Liverpool, or free on rail Swansea, at any time within the period named for shipment, on or before the 7th day of the month following the month named. Good merchantable spelter is defined as "virgin spelter resulting from the distillation of zinciferous materials." As in the case of lead, should the whole or any portion of the spelter for which the vessel's name has been declared to the buyer against the contract be lost on the voyage, and not come forward by any other vessel or vessels on the seller's account, the contract for the spelter so lost is void. There are no special regulations dealing with sampling or assaying.

REVIEW OF MINING

Introductory.—The fall in metals which commenced in April has continued. In particular tin and silver prices have suffered severely. With regard to tin, the fall is so serious as to jeopardize the existence of the Cornish mines. Dolcoath and Grenville look like having to close down. The report of the Committee on Non-Ferrous Mining has been issued, but no specific recommendation is made for temporary Government help at the present juncture. Deputations to the Board of Trade for such help are not likely to receive much substantial aid.

Transvaal.—The final report of the Low-Grade Mines Commission has been issued, but only brief cable messages as to its purport have so far been received in this country. From these it appears that the Commissioners are against State subsidies, and that they are of opinion that full inquiry should be held before any mine is allowed to close-down. A majority of the Commissioners, the labour members disagreeing, recommend that the colour bar should be removed, and that the piece-work system should be extended, thereby enabling the natives to earn higher wages, as well as more efficiently utilizing native labour. It is also suggested that inducements should be offered to the natives to remain at the mines for longer periods.

The Central Mining & Investment Corporation and Rand Mines, Ltd., both show unexpectedly large profits for 1919, that of the first named jumping from £397,073 in 1918 to £809,846, and that of the latter from £528,962 to £846,568. Central Mining has distributed £382,500 as dividend, being at the rate of 18s. per £8 share, as compared with a dividend of 10s. the year before. Rand Mines has distributed £531,498, the rate being 100%, as compared with 85% for 1918. The reports do not contain any remark indicating the cause of this increase in profits, but Rand Mines schedule of holdings goes to show that very many shares in subsidiaries and other Rand mining companies have been sold. No doubt advantage was taken to realize during the rise in quotations following the announcement of free sales of gold at a premium.

The terms of the sale of the City & Suburban mine to City Deep have been published. The purchase price is to be 45,000 City Deep shares of £1 each, at present quoted at about 45 shillings. The share capital of City & Suburban is £1,360,000 in £4 shares, which stood nominally at 7s. 6d. before the offer was made. As the engineers of the City & Suburban were of opinion that the remaining ore could not be extracted profitably by way of their own workings, the terms are distinctly favourable to the shareholders.

At City Deep the cost of operations has gone up from 21s. 7d. to 27s. 9d. per ton during the past two years, owing chiefly to the smaller tonnage treated, the figures having fallen from 744,100 in 1917 to 617,800 in 1919. The fall in the tonnage was due entirely to scarcity of labour; the position in this connection has substantially improved since the turn of the year. The yield per ton at par was 39s. 6d. in 1917, 38s. in 1918, and 38s. 4d. in 1919. The gold premium brought the last-named figure to 42s. 7d., and of the total net profit, £462,566, no less than £133,115 came from this source. The ore reserve at December 31 last was estimated at 3,418,050 tons averaging 9·4 dwt., as compared with 3,342,700 tons averaging 9·6 dwt. the year before.

With regard to the closing of the Princess Estate, announced last month, an official committee of inquiry appointed by the Mines Department has made an investigation into the circumstances, and agrees that it would be impossible to continue working. One result of the suspension of operations will be that more water will go into Durban Deep. While writing of water troubles ensuing from stoppages, it may be mentioned that Sir Harry Ross Skinner has pointed out once more that a stoppage at East Rand Proprietary would be a serious calamity to all the mines between this property and the Geldenhuis dyke. It is suggested that should the mine cease operations pumping should be continued at public expense.

For some time the Heriot has been struggling against fate. It is now announced that mining was suspended on May 29, and that a final clean-up is in hand. This is one of the smaller original mines on the outcrop in the central Rand, and was a stable-companion of the City & Suburban, with offices in Natal. The total dividends distributed amounted to 1,337½%, on a capital that had remained at £115,000 since 1895.

As briefly announced last month, operations at the Jupiter have been suspended. It will be remembered that this low-grade deep mine has paid few and small dividends since milling started in 1908, a result that did not bear out the expectations prevalent when 115,000 shares of £1 each were offered at £4. 10s. each. The mine was closed from October, 1913, to May, 1915, from the latter date onward only the eastern part of the mine being reopened. The report for 1919 showed a net profit of £8,541, but during the months February, March, and April losses totalling £12,000 were incurred. The condition of the plant and workings has been deteriorating lately owing to shortness of funds, and more money would be required to put things in good order. Further capital would also be required for shaft-sinking and development. As no more capital is forthcoming there was, therefore, no alternative but to abandon the mine.

The position at Simmer Deep before closing last month was even worse than that at the Jupiter. Though £57,615 was received as gold premium, the working loss was £7,512, and in addition £43,120 was due as debenture interest.

The Welgedacht Exploration Company announces the closing of its colliery. The property is to the east of Modder East and Geduld, and north of Grootvlei. Bore-holes had proved the existence of banket, and ten years ago shaft-sinking was begun. On account of water troubles the shaft was not sunk below 724 ft., and subsequently the operations were confined to coal-mining in the upper levels. Nothing has been said lately of the intention of the board in connection with the gold-mining rights.

Rhodesia.—The Lonely Reef gold mine has been operated by the present company for ten years, during which time the ore-body has been developed from the 3rd to the 23rd level, 479,466 tons of ore has been milled, gold worth £1,799,354 has been extracted, and the dividends have totalled 230%. At the present time the ore reserve is greater than ever before. The developments in the lower levels are in uneven ground, but the general results are satisfactory. When the present hoisting plant was installed, a cautious policy with regard to the persistence of ore provided for a depth of 2,000 ft. below the 9th level on the slope. This has already been exceeded, and additional equipment will be required before long. Particulars of the results for 1919 and of the ore reserves are given elsewhere in this issue.

The whole of the profits at Globe & Phœnix are now being put into development, with the exception of the amount received as gold premium. The directors' report, dated May 19, stated that the amount received from this source to date was £61,894, and they recommended the distribution of £60,000 as interim dividend for 1920, being at the rate of 1s. 6d. per 5s. share. The report announced that the exploratory work had so far yielded disappointing results, but at the meeting of shareholders a later cable was read announcing more promising developments. Though the actual figures did not show that any continuous run of profitable ore had been found, the discoveries encourage the directors to go ahead with the work. The ore reserve at December 31 last was estimated at 108,182 tons averaging $32\frac{1}{2}$ dwt. per ton, of which about 40% is in pillars.

The latest progress report issued by the Rhodesia Broken Hill gives the following details of exploratory work, which should be read in connection with Mr. S. J. Speak's article in the Magazine for October last. Trenches in blocks P. Q. R. 24, 25, and 26 have disclosed fair-grade lead ore and a considerable amount of vanadium ore. A pit 30 ft. deep has been sunk on a small outcrop a little to the south-east of No. 3 kopje; a cross-cut at that depth has disclosed ore over a distance of 30 ft. averaging 5% lead and 16% zinc. An adit cross-cut is being driven at the eastern end of No. 2 kopje; 57 ft. of zinc ore has been passed through, and the foot-wall has not yet been reached. The main shaft is being sunk with little interference from water, the cementation having thus far proved effective. The erection of the third lead-smelting furnace is well advanced, and most of the material for the fourth furnace has been shipped. Foundations for the new 1,000 kw. power-house are in place, but progress is being hampered by delays in shipment of material from England. Two metallurgists, with special experience in the treatment of zinc ores, have arrived at the mine and will erect the necessary experimental plant for working out the required details for the construction of a plant for the recovery of zinc on a commercial scale. The company's May output was 1,250 long tons of lead, as against 1,286 tons in April.

The political future of Rhodesia remains unsettled. The recent elections in Southern Rhodesia and the resolution passed by the Legislative Council combine to show that the local desire is for independent responsible government. The residents are not in favour of amalgamation with the Union of South Africa, and the authorities in London do not consider that the country can bear the financial burden of responsible government. It appears as if no change would be possible at present.

West Africa.—The Taquah Central Mines Co. is about to resume operations, having made an arrangement with the Taquah Mining & Exploration Co. for the subscription of additional capital. About £60,000 will be provided by this means. Messrs. Bewick, Moreing & Co. are retiring from the position of general managers, and the management will be in the hands of the Taquah Mining & Exploration Company.

The Ashanti Goldfields Corporation reports a net profit of £60,221 for the half-year ended March 31, of which £57,992 came from gold premium received during the eight months from July 1, 1919, to February 29, 1920. During this time 30,172 tons of ore was milled, for a yield of 31,540 oz. The tonnage was much less than normal, for causes already enumerated in our pages. The labour and fuel position is improving, but the labour supply is still far from satisfactory.

A company called West African Diamonds, Ltd., has been formed, with a capital of £12,000, by the Appollonia Gold Fields, Ltd., and others, to explore for diamonds under the direction of Messrs. Innes, Macdonald, & Seale. The company has an option on parts of the district where Mr. A. E. Kitson made his discovery last year.

Nigeria. — We recorded recently that Levers, of soap fame, had bought the control of the Niger Company. In order to provide capital for further expansion the capital of the company is now being increased from £3,000,000 to £10,000,000 by the creation of 7,000,000 8% preference shares, of which 3,000,000 are to be issued forthwith.

Australia.—The New South Wales Government has requested its Board of Trade to hold an inquiry into the position at Broken Hill. The whole economic position is to be examined, and the relation of profits to wages and rate of output will be fully investigated. Attempts have been made to bring masters and men to some sort of agreement at a round-table conference, but without avail.

The report of the Zinc Corporation for 1919 shows a profit of £77,377 accruing from the sale of lead concentrates produced from January 1 to May 6 of that year, the mine and works having been idle since the latter date owing to the strike at Broken Hill. The amount of South mine ore raised and treated during that period was 51,141 tons averaging 15·5% lead, 9·1% zinc, and 2·8 oz. silver per ton. The yield of lead concentrate was 10,735 tons, averaging 64·4% lead, 6·7% zinc, and 9·9 oz. silver. The zinc tailing produced was 15,954 tons, averaging 17·3% zinc, 4·1% lead, and 1·8 oz. silver; this, together with 83,610 tons of dump material was sent to the zinc concentrator, the average content of the whole being 15·4% zinc, 4·7% lead, and 5·3 oz. silver. The yield of zinc concentrate was 25,460 tons, averaging 47·8% zinc, 7·5% lead, and 9·7 oz. silver; there were also produced 2,134 tons of lead concentrate, averaging 56·8% lead, 15·2% zinc, and 25·4 oz. silver, and 3,346 tons of zinc slime, averaging 37·9% zinc, 14·7% lead, and 19 oz. silver. The ore reserve in the South mine is estimated at 2,114,600 tons averaging 14·6% lead, 9·4% zinc, and 2·6 oz. silver, being an increase of 38,600 tons as compared with the year before. These figures do not include the ore in the parallel zinc lode. The development work, though restricted by labour conditions, disclosed some interesting results. The diamond-drill hole on the 10th level intersected ore 90 ft. wide, averaging 14·7% lead, 9·9% zinc, and 2·2 oz. silver; this, combined with stripping results, shows that the ore-body has the same characteristics on this level as on those immediately above.

The report of the British Broken Hill issued last month covered the half-year ended December 31 last. As the mine and works were idle during this period owing to the miners' strike, there was no output to record. The accounts, however, showed a revenue of £87,424 from the sale of concentrates, and a profit of £21,124, which was carried forward. The ore reserve is estimated at 1,071,661 tons, averaging 12·4% lead, 11·3% zinc, and 6·6 oz. silver per ton.

The Golden Horse-Shoe report for 1919 shows a profit of £38,190, of which £34,508 came from gold premium. The amount of ore treated was 105,588 tons, and the total output of gold was 47,501 ounces.

Cornwall.—The position of many of the mines in Cornwall has been rendered critical by the heavy fall in the price of tin. This matter, and the report of the committee on Non-Ferrous Mining, are dealt with by our Camborne correspondent.

The Redruth Tin Ticketings have been on a very restricted scale lately, but the smallest amount of business on record was transacted on May 31, when there was only one seller, Tincroft, which offered ten tons. Possibly some of the producers are holding back for an improvement in the price of tin.

In the May issue our Camborne correspondent commented on the unfortunate association of instructors in the Camborne Mining School with the Calloose Mining & Alluvials Co. We have received from the Governing Body of the School the following communication with regard to this matter:

"It has always been the rule of the School that the instructors do not undertake outside work except with the permission of the Governors, and that reporting on properties for the purpose of publication in connection with the flotation of companies has not been permitted. It was, therefore, a matter of extreme regret to the Governors to learn from the prospectus of the Calloose company that use had been made of reports written by members of the staff in their private capacity and without the sanction of the Governors. They immediately took the steps which they thought desirable to prevent any repetition of the same." The Governors are to be congratulated on their firm stand.

North Wales.—The Coed Mawr zinc-lead mine in Carnarvon is being worked on option by the Gel Tin Lode & Alluvial Co., a member of the New African Company group formerly interested in Nigerian tin. Mr. H. M. Ridge reported on the Coed Mawr property, and is now directing its development. The outcrops of two lodes have been traced for some distance on the surface, and one of these is to be opened up by adit.

United States.—At the Alaska Treadwell group of mines, the only mining work now being done is at the Ready Bullion, where the profit, however, is small owing to the great increase of costs. It has been determined to suspend development and filling, and to recover as much ore as possible before abandonment. On this plan mining will continue for two or three years. Ore is also to be won from the west end of the Treadwell open-cuts. The waste is to be tipped so as to fill the break where the sea entered the workings in 1917. If this break can be closed, it will be possible to remove the water and extract ore remaining in the upper levels. There is some chance also that ore below the break will be rendered accessible, but it may not be profitable to conduct mining operations at so great a depth under present economic conditions.

The United States gold mines, of course, do not enjoy the advantage of a gold premium, while their costs are as high as, or even higher than, those in countries where a premium is obtained. This fact, as well as the gradual exhaustion of known ore deposits, is causing a diminution of production. The output in 1919 was $58,488,000, as compared with $68,493,000 in 1918 and $101,035,000 in 1915. It is believed that the figures for 1920 will be less than $50,000,000. The official reports show that the consumption of gold in the United States for manufacturing purposes was over $80,000,000 during 1919, a figure higher than the home output, and not allowing anything for currency purposes. In order to help the gold producers, it is now proposed, under the McFadden Bill, to grant a bounty of $10 per ounce on all gold that is used for industrial purposes, this money to be provided in the form of a tax when the gold is sold.

Drilling for oil is to be commenced shortly in Alaska, on land recently thrown open to prospectors. The oilfields are in the coastal district west of Mount St. Elias, and experts of the Geological Survey estimate that the oil lands cover one million acres. There are five chief districts, Gold Bay, Katalla, Yakataga, Cook Inlet, and Alaska Peninsula. Wells have been producing at Cordova for some time. It is believed that all the oil produced in Alaska will be used locally.

Mexico.—Since our announcement last month of another revolution in Mexico, President Carranza has been murdered and De La Huerta has succeeded to his position. This Huerta is not the Huerta who was prominent a few years ago. He was recently consul-general in New York and eighteen months ago he was appointed Governor of Sonora.

A cable issued by the Santa Gertrudis Company on May 27 announced that the El Bordo mine is in full operation again, the damage caused by the serious fire of two months ago having been made good.

Russia.—It is reported that a cargo of Caucasian manganese ore has been delivered to ironworks in Cumberland, this being the first consignment since the outbreak of the war in 1914. Whether this means that mining has been resumed or not is not clear. The probability is that the cargo came from stock.

France.—Reports have been circulated to the effect that oil has been discovered in Haute Savoy. These reports are somewhat misleading. The facts are that traces of petroleum are known to exist and that companies have been formed to conduct drilling operations.

Recently it was mentioned that the Russo-Asiatic Consolidated had been paying attention to metal mines in France. A circular issued this month gives particulars. The company has obtained an option to purchase the share capital of a French company owning the Villemagne concession in the Departments of Gard and Lozere. The property was worked in ancient times, and for some years past the French company has developed ore and has erected modern plant. The ore consists of argentiferous lead-zinc sulphides.

THE TIN DEPOSITS OF NORTHERN NIGERIA.

By FRANK M. LUSH.

The author compares the geology of Northern Nigeria with that of the tinfields of New South Wales, and discusses the application of pump-dredges and bucket-dredges to the Nigerian deposits.

LITTLE has been written, and not much more is known, of the geology of the tinfields of Northern Nigeria. My own experience goes to prove a substantial resemblance of these areas to the New England tinfields of New South Wales, and I have in fact noticed almost exact replicas of tin deposits in these two widely-separated countries. It may seem illogical to commence an article on the geological features of one country by quoting from the description of the geology of another country on the other side of the world, but as this method of comparison has been helpful to myself, I feel justified in placing the matter before your readers from the same point of view. It is not necessary, therefore, to give any apology for beginning this article by quoting the following extract from the report on the Tingha-Inverell district by Mr. C. S. W. Wilkinson, Government Geologist of New South Wales from 1874 to 1891:

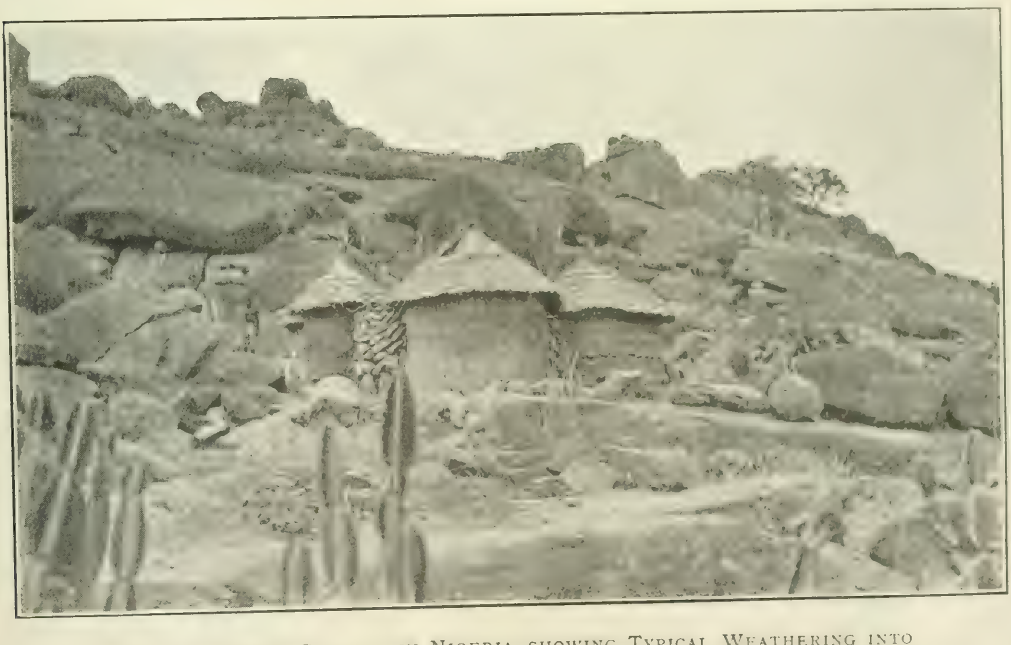
"For clearness of description, it may be well to arrange the formations separately in the following order:

Recent	QUATERNARY
Pleistocene	
Pliocene	TERTIARY
Miocene	
Carboniferous	
Granite	PRIMARY
Greenstone	

"I would here premise that, in using the above terms Pleistocene, Pliocene, etc., I do so in a measure provisionally as expressing the relative ages of the formations to which they are applied.

"*Recent* embraces all those river drifts, alluvial, and other surface accumulations which are in course of formation at the present time.

"*Pleistocene* includes those drift deposits forming alluvial flats which are found more or less in all the valleys, and through which most of the present streams have worn their channels. They consist of gravel, sand, clay, and loam, varying in arrangement, and their composition depending very much on the nature of the rocks from which they have been derived. Thus in granite country the detritus is of a



COARSE-GRAINED GRANITE IN NIGERIA, SHOWING TYPICAL WEATHERING INTO ROUND-SHAPED BOSSSE.

coarse, sandy character, with a little coarse drift; that from the older Tertiary formation consists chiefly of water-worn gravel and sandy ferruginous clays; from the basaltic trap have resulted thick deposits of black and red loamy clay. . . . .

"In the creeks and gulleys traversing the granite country the alluvial deposits are all tin-bearing, but, being often of considerable thickness, are not so easily worked, on account of the great amount of stripping required, as the shallower and more recent drift along the beds of the creeks.

"Besides the alluvia along the creeks, several rich patches from 1 to 4 ft. thick have in various places been opened, the wash dirt requiring but little stripping and yielding from 15 to 30 lb. of tin ore to the cart-load of dirt.

"*Pliocene.* Next in order of sequence is the basaltic trap. For the miner this volcanic rock has but little interest, but to its influence the best pastoral and agricultural land chiefly owes its fertility.

(This was written before the stanniferous deep leads beneath the basalt were discovered and worked, but Mr. Wilkinson clearly predicts the discovery of these).

"*Miocene.* The rocks of this period are of much economic importance on account of the valuable deposits of stream tin which some of them contain. The formation must have been of considerable thickness and seems to have once covered nearly the whole district, for it is found on the summits of hills, and again filling some of the intervening depressions. The upper part consists of sandy concretionary ironstone which sometimes assumes a pisolitic structure, from the small ferruginous concretions composing the mass. Where this is the case, the surface of the ground is often strewn with small round ironstone pebbles of the size of a pea. The ironstone is now chiefly found in outliers forming those 'red hills,' as they are locally called, which constitute such marked features in the country between the Macintyre and Cope's Creek.

"Underlying the ironstone are red and white sandy clays, and beneath these water-worn drifts and conglomerates, the latter usually occupying the sides and bottoms of the ancient valleys, and containing the tin-bearing deposits.

"Owing to the enormous denudation this formation has suffered, the overlying clays and ironstones have in places been entirely removed, leaving the stanniferous gravels exposed near the present surface and, therefore, easily accessible to the miner. Such is the case at Elsmore, Stannifer, and other important tin mines.

"At the Elsmore mine, this old alluvial drift has been broken up and re-deposited, forming shallow surfacing near the top of a hill, where it is now being worked, but in another part it lies undisturbed and consists of a hard conglomerate, the water-worn boulders being cemented together with silicious cement.

"*Carboniferous.* (I have not noticed this formation on the plateau. F.M.L.).

"*Granite.* Two distinct granites are described, one a medium to coarse-grained acid granite which on weathering breaks up into angular masses, and the other a medium-grained and porphyritic biotite grey granite which weathers into round shaped bosses."

With the exception of the Carboniferous formation and greenstone, which I have not noticed on my visits to Nigeria and are of no economic importance in regard to tin, the above extracts exactly describe the conditions existing on the Bauchi Plateau.

Taking Mr. Wilkinson's terms as a standard, the following remarks apply to the formations in this country generally:

Recent. In some places they contain tin ore, but are more often valueless, and were the cause of many good properties being adversely reported upon in the early days of the tinfields by engineers who had no knowledge of the geology of alluvial formations. These, of course, exist everywhere and, where found valueless, the other formations in close proximity were overlooked. The amount of tin obtained from these is not great.

Pleistocene. The amount of overburden varies considerably and in many places carries an appreciable amount of tin, which can be recovered when these formations are worked by means of machinery. At present most of these deposits are worked by hand labour, and only the rich bottom layer of wash treated. When worked by machinery the whole mass is passed through the tin-saving appliances and all the values extracted. The main source of the tin won is from this formation and will be for many years to come, as there are enormous quantities scattered over the country.

Pliocene. Basalt abounds to a large extent in certain districts and several extinct craters exist. Tin-bearing wash has been discovered beneath this in one locality at a shallow depth. There is nothing to prevent deposits being discovered such as the deep leads in the New South Wales tinfields. The surface indications clearly point to this, and these will no doubt become large producers in the future. At present economic reasons would probably prevent working except under extremely favourable

Fine-Grained Granite in Nigeria, showing Typical Weathering into Angular Masses.

Flats in Nigeria, through which Shallow Leads (Pleistocene) Occur.

conditions. The Vegetable Creek deep leads of New South Wales have produced an average of over 2,500 tons of tin ore per mile of lead.

Miocene. This formation is clearly shown by the flat-topped hills which are prominent all over the Plateau and known locally as "laterite." A great number of the Pleistocene formations consist of the material denuded from this. These hills stand up prominently above the present level of the country, which at one time must have been at a very much higher altitude, and are either the remains of old drainage channels or a large inland lake. The presence of well water-worn wash seems to indicate the former. The ironstone capping has enabled portions to withstand the general denudation of the country. Tin is being won from these deposits, but sufficient attention has not yet been paid to their great possibilities.

From the above it can be plainly seen that where large alluvial formations exist the probabilities of tin lodes existing are very slight. The rocks which contained the lodes have all been eroded and the mineral contents concentrated in the Tertiary formations. The earlier Tertiary formation, Miocene, has again been broken up to a very great extent and the tin reconcentrated into the Pleistocene formation. The small lodes, leaders, and shoots which are now found in the granite are probably the remains of lode formations at one time some thousands of feet in depth.

For the purpose of economic working, tin deposits may be classified as follows:

(1) Surface deposits.
(2) Terrace deposits.
(3) Leads, deep and shallow.

Surface Deposits. This term is applied when the tin ore is found on or close to the surface and generally above the present water-level. They may be either Recent or Tertiary formations. When of the latter they are known as terrace deposits.

The Recent surface or detrital deposits are formed by the denudation and breaking down of present lodes or series of quartz veins (pegmatites). The tin ore is angular and little water-worn, and frequently grains are still found adhering to the matrix. Large crystals of tin ore as well as the ruby and rosin varieties are found in some of these deposits. They are seldom of any very great extent, and the tin contents are patchy, as would be expected by the mineral not being disturbed sufficiently to concentrate into any regular runs. Owing to this fact they are not very great producers, but their presence sometimes indicates good deposits in the adjoining valleys.

Terrace Deposits. As the name indicates, this term applies to deposits above the present drainage channels or water-level and may be a considerable distance away from a stream. Sometimes they are found along the sides of valleys containing the more recent Tertiary formations. They may occur with little or no overburden, or may be buried under a considerable thickness of this material. However, they can be readily distinguished from the Recent surface deposits by the water-worn character of the wash stones and tin grains, which are more evenly distributed throughout the mass.

The same principles of working surface and terrace deposits apply to each. There are invariably good facilities for the disposal of tailings, and if sufficient water can be obtained, preferably under natural pressure, the working costs are extremely low. Where natural head is not obtainable, a pressure pump for breaking down and disintegrating the mass is a great advantage when the cost of power is reasonable.

In considering and laying-out a scheme for the working of these deposits, it must be borne in mind that the output depends on the amount of water available for treatment. One cubic yard of material requires 3,000 gallons of water to break it down and carry it off at a sufficient grade to save the tin contents. Therefore, to treat a quantity of, say, 20 cu. yd. per hour, 1,000 to 1,500 gallons of water per minute is required.

Leads. These can be divided into shallow and deep.

Shallow Leads. This term is applied to those generally of the Pleistocene formation. The overburden consists of drifts and clays which enables the deposits to be worked more economically by the open-cut method, that is, dredging, sluicing, or hand labour, than the ordinary underground method of shaft sinking and blocking out. The overburden may be of any depth from a few feet to over one hundred below the water-level of the country. Where sufficient head water is available to treat a quantity and a tail race cut up to command the deposit, working costs are extremely low. When these conditions are present, it is more advantageous to expend capital on head and tail races, pipe-lines, and dams, than on machinery for elevating. I know instances of working miners cutting 10 to 20 miles and more of races to get water on to their claims. In some countries it is illegal to deposit tailings into rivers, and then machinery has to be used for elevating and stacking where otherwise a tail-race could be utilized.

TYPICAL OVERBURDEN OF A SHALLOW LEAD (PLEISTOCENE) IN NIGERIA.

Owing to the dry season in Northern Nigeria, this method requires careful consideration of all conditions before a large outlay is expended on dams and races, but there are many deposits there which are favourably situated with regard to this.

The main bulk of these leads on the Plateau require the use of elevating machinery to work them in an economical manner and obtain a regular output. The cheapest method of elevating is by employing water under pressure through jet elevators. The use of these depends on local conditions, and they cannot be employed during the dry season.

The two main methods of raising and treating dirt in quantities which require power are pump-sluicing plants and bucket-dredges. Each of these systems has its own advocates who, of course, point to working costs, recoveries, and failures on both sides.

The suitability and efficiency of these two methods is determined by the nature of the ground to be operated on. Rough, uneven bottoms with joints, cleavages, or other crevices, large boulders, or granite bars, are best treated by the monitors of the pump-sluicing plants. Soft, rotten, and fairly even bottoms, on the other hand, may be more economically worked by the bucket-dredge.

The former description applies to the deposits I have examined in Northern Nigeria, with the exception of two or three, which will require further investigation before the type of machinery to be provided for working is decided upon.

In 1909, on the tinfields of New South Wales, there were 31 pump plants in operation and 2 bucket-dredges.

When a power company materializes in Nigeria, all these deposits will be easily worked for the greater portion of the year, and most of them, by means of return-water pumps and the help of the seepage water, the whole year round.

The capital outlay to the mines will be considerably less by adopting the semi-portable type of pump-sluicing plant against the costly bucket-dredge.

The standard type of pump plant, which will prove the most satisfactory with, of course, modifications to suit individual deposits, will consist of the following: One gravel pump and motor direct-connected on the same bed-plate; one nozzle or monitor pump direct-connected as above; pipes for pumps, sluice-boxes, and the necessary electrical gear. The pumps and motors can be raised on to low trucks when required to be moved up to the working face or transported any short distance across country.

A mistake I have noticed frequently in reports on these propositions is that of assuming that the same output can be obtained from shallow ground, 6 to 10 ft. in depth, as from deeper ground, 30 to 40 ft., of the same average value and at the same working cost. Ground 6 ft. in depth, average value 2 lb., contains 8 tons to the acre; 21 ft. 30 tons; 30 ft. 42 tons; 42 ft. 60 tons. If a plant is erected on 21 ft. ground to treat 75 cu. yd. per hour, it will approximately treat one acre a month and return 30 tons. If the same-size plant is erected on 6 ft. ground the output will be the same, but 4 acres will be treated in the month. Similarly, a plant to treat 100 cu. yd. per hour would be erected on 30 ft. ground. This would then work out at an acre a month and obtain a return of 40 tons. On 6 ft. ground, 5 acres per month would have to be treated for the same return.

If a plant capable of dealing with 75 or 100 cu. yd. per hour is erected on 6 ft. ground, the efficiency will within a few days be so low, owing to the large area worked over, that at the end of the month the average yardage would probably be reduced to 30 cu. yd. per hour. The output would thus drop to 10 or 15 tons, and area treated about 2 acres, a drop in efficiency of 50%.

The practical method of obtaining the same output in this case would be the erection of four smaller plants which would be able to work at their full capacity the whole month, but the working costs would be four times as much as with the one large plant on deeper ground.

Deep Leads. Deep leads are those under basalt flows, the thickness of which varies considerably from a few feet to about 300 ft. in different districts. They are generally discovered by surface conditions, and are sometimes observed either entering or leaving a sheet of basalt. Prospecting by boring is also carried out in favourably situated country. One rich lead in New South Wales was nearly missed by this means, as after a shaft was sunk a large granite boulder was discovered only two feet away from the bore-hole. If the bore had struck this boulder the lead would probably have been missed.

They have been large producers of tin, as the wash has been found extremely rich, in some places yielding $1\frac{1}{2}$ cwt. to the cubic yard, but they can only be worked by the ordinary sinking of shafts and blocking out the ground. It will probably be some time yet before they are worked in Northern Nigeria.

Geological maps of the two principal tin-mining districts in New South Wales show roughly 50 miles in length of Recent and Pleistocene deposits (shallow leads) and 60 miles of deep leads capped by basalt, laterite, pisolitic ironstone, and volcanic dust.

From these deposits 116,000 tons of tin ore have been won between the years 1875 and 1910. Although the output of the shallow and deep leads is not shown separately, I consider that at least 75% of the above amount has been obtained from the former, say, approximately 90,000 tons from a length of 50 miles of stream beds.

As many of the properties in Northern Nigeria have 20 miles and over of these deposits, which are of about the same value as those in New South Wales, it may be presumed that the Nigerian tinfield will be a very much larger producer.

It is interesting to note that in New South Wales 40 acres only could be taken up for mining purposes, and a dredging lease granted on so-called worked-out ground consisted of 100 acres. In 1900 the first pump-dredge was erected on Cope's Creek, which was then an abandoned worked-out field, and in 1910 some 40 plants of various sizes and types were operating in the district. This machinery was all erected for re-treating deposits already worked by the ordinary hand methods of individual parties of miners, and from which 80% of the mineral values had been recovered. Nigeria has all these similar deposits still virgin, and in this respect offers more inducement for the outlay of capital on suitable machinery and plant to economically treat them.

Lead Pigments.—The Home Office has issued the report of a Departmental Committee on the dangers attending the use of lead compounds in painting and enamelling coaches and other wood-work. The recommendation is that a regulation should be made prohibiting the use, after three years, of any pigment containing more than 5% of a soluble lead compound. The chief danger in handling lead paints arises when the paint is sand-papered in order to remove unevennesses before varnishing.

THE VENTILATION OF DEEP MINES

By DAVID PENMAN, B.Sc., M.Inst.M.E.

The Author gives an outline of the problems in connection with the ventilation of deep and hot mines.

IN the ventilation of deep mines the problem of greatest urgency is not so much the dilution of the noxious and inflammable gases given off from the strata or from other sources, as the cooling of the atmosphere to an extent that will allow the miners to carry on their work with a reasonable degree of comfort and a fair measure of efficiency.

CAUSES OF HEATING OF THE AIR.—There are many causes which tend to raise the temperature of the air-current as it circulates through the underground passages of the mine. Primarily it may be said that the heating is due to the natural heat of the strata. It is well-known to geologists and to miners that the temperature of the rock strata forming the crust of the earth increases with the depth. At a depth of about 50 ft. from the surface there is a line or zone following approximately the contour of the surface at which

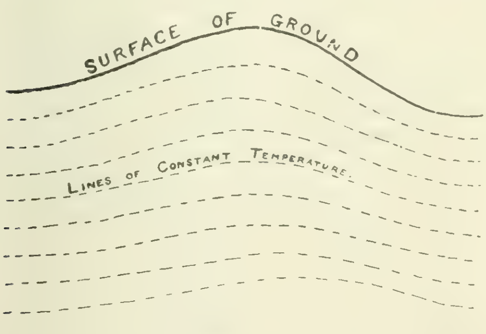


FIG. 1.

the temperature is constant and independent of climatic variations (see Fig. 1). The actual temperature 50ft. below the surface depends upon the locality and may be taken to equal approximately the average temperature of the locality throughout the year. This line of constant temperature is called an isothermal line or a geo-isotherm. Below this line the temperature increases at a rate varying from 1°F for every 30 ft. in depth to 1°F for every 230 ft. or so in depth, depending upon the locality. The rate of increase of temperature is called the temperature gradient or the geothermic gradient.

In the coal measures of the Midlands of England the average increase is approximately 1°F for every 65 ft. in depth. But even in the coal measures the temperature gradient varies considerably. For instance, in a bore-hole in shale near Glasgow, Professor Everett found that up to a depth of 450 ft. the temperature increased 1°F for every 30 ft., whereas at Dukinfield, in Lancashire, the temperature gradient was 1°F per 72 ft. It has been found, too, that the gradient is less steep in measures which are highly inclined than in measures which are flat, pointing to the suggestion that the heat from the interior of the earth is conducted more readily along the bedding planes than across them. Koenigsberger and Muhlberg found that the geothermal gradient was higher under mountains than beneath valleys, that is, the lines of equal temperature open out under mountains and come closer under valleys.

It is to be expected that rocks which have a low thermal conductivity will tend to induce a high geothermic gradient, and that rocks of good conductivity will conduce to a low geothermic gradient. The rocks having a low thermal conductivity will prevent the heat from passing outward so readily as it will do in strata which have a greater conducting power. Thus, if one were to consider a vertical section of strata comprising shale, sandstone, coal, and, say, igneous intrusion, the temperature gradient would vary in the different rocks. It has been found, for example, that slate rocks have a higher temperature than granite at the same depth and in the same locality. In metal-mining districts the country-rock is generally warmer than the metallic veins or lodes, because of the greater thermal conductivity of the latter.

The presence of what might be termed extraneous heating or cooling agents also affects the temperature gradient in some localities. For example, the presence of the large body of cold water so cools the strata at the Calumet & Hecla copper mines, Lake Superior, that the temperature gradient is only 1°F per 224 ft., while at the Comstock mine, Nevada, the increase is 1°F per 33 ft., largely because of the heating effect of hot water in the lode due to volcanic action.

The increase of rock temperature in the gold-mining area of the Rand is extremely low, being in some districts less than 1°F per 200 ft. in depth. In Cornwall the increase is approximately 1°F for every 100 ft. Fig. 2 compares the geothermic gradient in these two places with that in the British coal measures. The graphs are assumed to start from a common origin.

In addition to the natural heat of the strata there are other things which affect the temperature of the air-current in its passage through the mine. Some of these pertain to all mines and some pertain more specifically to coal or shale mines. Some of these influences are positive, that is, they increase the temperature, while others have a negative effect in that they tend to lower the temperature.

Consider first the further causes of heating. These may be grouped as follows:

(*a*) The air is heated by the adiabatic compression of the air in the downcast shaft. It

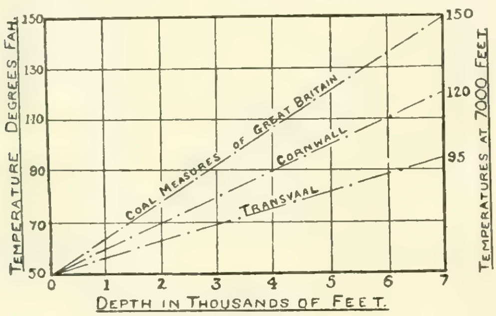


Fig. 2.

can be shown that the temperature of the air is increased by nearly 5½°F for every 1,000 ft. the shaft is in depth, and this is solely due to the compression of the lower strata of air by the column resting above them. Thus in a shaft 3,000 ft. in depth the temperature of the air at the bottom of the shaft would be about 16°F above the temperature at the entrance to the shaft from this cause alone. Of course the compression in the downcast shaft is counterbalanced by an equivalent expansion of the air in the upcast shaft and in rise workings, but in the shaft, at any rate, any cooling arising from the expansion is of no value whatever so far as the ventilation of the mine is concerned.

(*b*) The ventilating current is raised in temperature by the heat given off from the bodies of workmen and animals, from lamps, from electrical machinery, and from any underground fires that may exist.

(*c*) The friction of the air-current in its passage through the mine is a third source of heat. Indeed, practically the whole of the energy expended in ventilating the mine is converted into heat through the friction of the air in the mine passages. In most cases, however, it can be shown by calculation that the heating effect from this source is small.

(*d*) One of the chief causes of rise of air temperature is the oxidation of timber and coal. In metalliferous mines the effect is not so pronounced as in coal mines, for obvious reasons, but in the latter it is so important as in some cases to be the chief factor in the rise of the temperature of the mine air. Dr. Haldane has made a calculation from analyses of a sample of air taken from a Staffordshire colliery, in which it appears that the disappearance of 0·01% of oxygen corresponds to the production of sufficient heat to raise the temperature of the mine air 2·65°F.* Now in the particular sample on which the calculation was based the disappearance of oxygen amounted to 0·96%. The heat produced in this instance was sufficient to raise the temperature of the air 254°F. Needless to say the temperature in the mine from which the sample was taken was well below this figure. Of the heat produced in the oxidation process only a small portion goes to raise the temperature of the air, most of it being taken up by the strata surrounding the workings. Nevertheless it will be clear from the data that oxidation may in many cases play a very important part in the rise of temperature of the air-current in its passage through the mine. Cases have been recorded by Dr. Haldane and by other investigators in which the air temperature in the working-places was several degrees above the actual rock temperature.

In order to reduce oxidation to a minimum in coal mines it has been proposed to drive the main airways in the stone or rock immediately above or below the coal seams. The chief drawback here is the additional expenditure in developing the mine. Another proposal is to line the main roads with brickwork. This is often done for other reasons besides the elimination of oxidation.

Cooling Influences.—There are at least three influences tending to cool the air of a mine. These are (*a*) the emission of firedamp and other gases from the working faces and adjacent strata, (*b*) the de-compression or expansion of the air as it rises from the deeper to the shallower parts of the mine, and (*c*) the evaporation of the water-vapour into the air-current.

(*a*) The cooling effect produced by the

* "The Investigation of Mine Air."

gases given off at the face of work is due to the lowering of temperature produced by expansion. The gases are pent up in the pores of the coal, and sometimes in actual cavities or pockets. Occasionally considerable volumes of gases are enclosed in vacuities in the coal or other strata under enormous pressures. Cases are on record of pressures up to 400 lb. per square inch, and on several occasions, in coal mines, disasters have occurred through the bursting of a too-attenuated barrier of coal by the enormous pressure of the pent-up gases. In such cases, where gas, in expanding, does the work of breaking down a barrier, extremely low temperatures are produced, since the expansion follows more or less closely the adiabatic law. Under normal conditions, where the gas simply oozes from the working face, the fall of temperature may be more in keeping with that known as the Joule-Thomson effect, in which the cooling is very small compared with that due to adiabatic expansion. In general, however, the cooling is greater than that due to the Joule-Thomson effect alone, for the reason that the gas in escaping from many of the innumerable tiny pockets in the coal will eject splinters of coal or water and so perform work during expansion and produce a greater reduction of temperature than if the gas simply escaped without overcoming any resistance. It is difficult to compute the total cooling effect due to the emission of gas over a length of face. It will vary with the volume of gas discharged, and this will be affected by, among other things, the prevailing barometric pressure.

(*b*) The cooling resulting from de-compression can best be utilized by taking the air from the downcast shaft straight to the lowest parts of the mine and then allowing it to rise toward the upcast shaft. In this way the workings in the upper parts of the mine get the benefit of the cooling due to reduction of atmospheric pressure. Any cooling occurring in the upcast shaft itself is, of course, useless.

(*c*) The chief source of cooling in a mine is the evaporation of moisture into the air current in its passage through the workings. In order to consider this fully it will be necessary to dilate somewhat on the conditions under which air is capable of taking up moisture. Air, unless artificially dried, always carries with it in suspension a greater or less amount of moisture as water vapour. Under atmospheric pressure, the amount of moisture a given volume of air is capable of carrying in suspension is determined by the temperature. The higher the temperature the greater is the weight of water vapour that can be carried by the air. The air is said to be saturated when it contains the maximum weight of moisture possible at the prevailing temperature. The accompanying table gives in round numbers the weight of moisture carried at various temperatures by 100,000 cu. ft. of saturated air.

TABLE SHOWING THE AMOUNT OF WATER IN 100,000 CUBIC FEET OF SATURATED AIR.

Temperature in degrees Fahrenheit	Pounds of water in 100,000 Cubic Feet of Air
32	31
40	41
50	59
60	81
70	114
80	156
90	212

Air saturated at a given temperature will not be saturated if the temperature is raised without any more moisture having been taken up. On the other hand, if the temperature of saturated air falls, a portion of the contained moisture will be condensed and deposited on the cooler surfaces with which the air is in

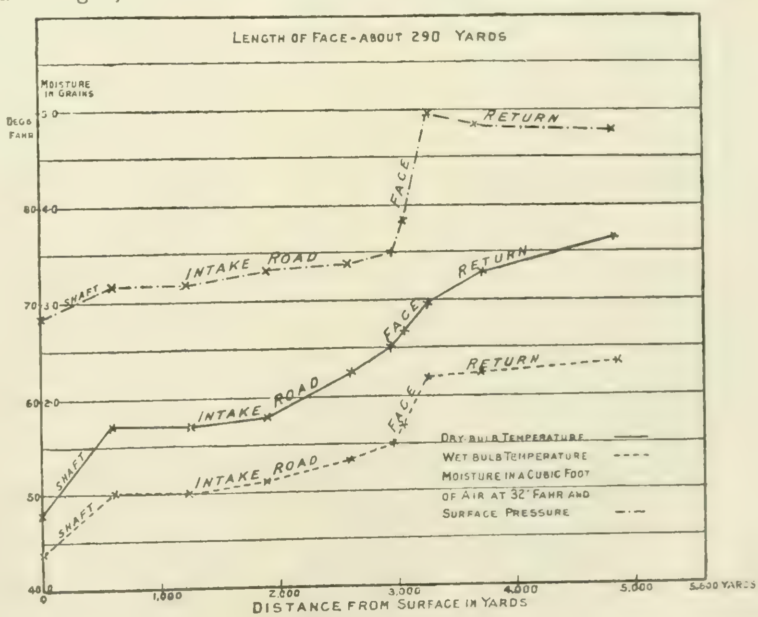


FIG. 3.

contact. Unsaturated air is constantly tending toward the condition of saturation. The air in its passage through the mine, for example, is continually absorbing moisture. Moreover, the temperature of the air is always rising, and, as can be learned from the above table, the air becomes more and more greedy for moisture the further it travels from the downcast shaft. Fig. 3, which is taken from the First Report of the Committee on "The Control of Atmospheric Conditions in Hot and Deep Mines,"* illustrates the kind of change taking place in the air-current of a mine in its passage through the workings.

The relative humidity of mine air is determined from the readings of the dry and wet-bulb hygrometer. The percentage saturation is determined from the readings by means of the hygrometric tables, or by the hygrograph chart prepared by Professor H. Briggs.

Referring to Fig. 3, it will be seen that there is a steady though variable rise of the temperature of the air from the time of entering the mine, and that the wet-bulb temperature increases in a similar fashion. The graphs may be taken as typical of the conditions in a modern, well-ventilated coal mine. From the graphs the following tabulations are made, the fourth column being obtained from hygrometric tables :

Position of Observation	Dry-Bulb Temperature degrees F.	Wet-Bulb Temperature degrees F.	Percentage Saturation	Moisture in 100,000 cu. ft. of air at 32°F and surface pressure lb.
Top of downcast shaft ..	48·5	43·5	67	40
Bottom of downcast shaft	51	50·0	61	45·7
Inbye end of main intake airway	65	55	52	50·0
Commencement of return airway	70	62	61	70·5
End of return airway	76·5	63·5	46	68·0

From the last column it will be seen that each 100,000 cu. ft. of air carries out of the mine 28 lb. of water. In the Bentley colliery (near Doncaster) where the measurements were taken, the total volume of air circulated was approximately 300,000 cu. ft. per minute. This volume of air, therefore, removes from the mine, every 24 hours, no less than 58 tons of water. In mines in which the wet-bulb temperature rises to a still greater value the weight of water carried out of the mine per 24 hours may easily run into three figures.

In the text-book already quoted a calculation is made showing that an increase of 1 grain of moisture per cubic foot corresponds to a cooling effect which would produce a lowering of the temperature of the air by 8°F. Or, putting it another way, an increase of 1 grain of moisture per cubic foot would neutralize the heating due to the disappearance of 0·03% of oxygen. Now in the case quoted, the increase of moisture per 100,000 cu. ft. of air is from 40 lb. to 70·5 lb., that is, say, 30 lb. from the time the air enters the downcast shaft till it leaves the last working face. One pound equals 6,990 grains. Therefore the increase of moisture per cubic foot $= \frac{30 \times 6990}{100,000} = 2{\cdot}097$ grains. This value agrees closely with that recorded on the graph in Fig. 3. This increase of moisture would therefore correspond to an absorption of heat which would cool the air rather more than 16°F. Moreover, this is a direct cooling effect, since practically all the heat required for the evaporation of the moisture must come from the air itself.

It should be explained that the cooling effect produced by the evaporation of moisture follows from the well-known physical phenomenon of latent heat. To evaporate 1 lb. of water, under the conditions obtaining in a mine, requires the expenditure of about 580 to 590 calories or about 1,050 British thermal units. One B.Th.U. would raise one pound of water through 1°F, but owing to the low specific heat of air, the same quantity of heat would raise fully four pounds of air through the same range of temperature, and, of course, there is the same difference when the effect is cooling instead of heating. The fact of the low specific heat of the air is a fortunate one for mine ventilation.

THE EFFECT OF HOT MOIST AIR ON THE HEALTH AND EFFICIENCY OF WORKMEN.—The evidence of many investigators goes to show that the factor which limits a man's capacity for work is not so much the actual temperature of the atmosphere in which he operates as the humidity, as represented by the wet-bulb temperature of the hygrometer. If the wet-bulb thermometer is above 80°F, with 85°F as a maximum, hard work can be carried on only for very short periods and under a considerable degree of physical distress. It is known that work can be carried on in temperatures up to 120°F provided the air is sufficiently dry, which means that the wet-bulb temperature should not be above about 80°F.

In a warm atmosphere hard physical work

*Trans. Inst. Mining Eng. Vol. lxiii., p. 231.

produces profuse sweating. In itself this is not a hindrance to prolonged exertion provided that the condition of the air is such that it readily evaporates the sweat produced and that sufficient water is drunk by the worker. The cooling effect produced by the rapid evaporation of moisture from the man's body tends to keep his body-temperature normal, and if, as stated, the hygrometric conditions are sufficiently favourable, work may be carried on for long periods in a warm atmosphere without injury and even with a fair measure of comfort. Of course, it goes without saying that a minimum of clothing should be worn in such circumstances. If, however, the condition of the air is such that the wet-bulb temperature is 85°F or over, the body-temperature tends to rise above normal and a condition of considerable danger arises. This is due to the fact that the air already contains so much moisture that its power for further absorption is low, and consequently the rate of evaporation of sweat from the body of the workman is slow. It may be said, therefore, that a wet-bulb temperature somewhere in the region of 80°F constitutes the limiting factor to the carrying on of physical work on an economic basis. The chief aim, therefore, in the ventilation of deep mines is to keep the wet-bulb temperature below this limiting value.

MINERS' ANÆMIA.—A warm and moist atmosphere underground forms an ideal breeding ground for a species of intestinal worm, known as *Ankylostoma duodenale*, which constitutes a danger to the mine workers. The worm infests the upper portion of the small intestines and either sucks the blood of its victim or secretes a substance which prevents the coagulation of the blood so that its bites bleed freely. Thus, the victim slowly becomes anæmic. As a consequence, weakness and ill-health result, and unless preventative and curative measures are taken, death may eventually supervene. The disease, known in medical circles by the term *ankylostomiasis*, is very prevalent in various tropical and sub-tropical countries. Frequently epidemics have broken out in Continental mines, and a few years ago there was a startling outbreak among the tin miners of Cornwall. The female worm of the species produces ova in great numbers, which may be found swarming in the excreta of persons who are affected by the disease. The ova do not hatch within the human body, but develop most readily into the larval state under the conditions found in a deep mine, namely, warmth, moisture, and darkness. Hatching proceeds best at temperatures between 70°F and 98°F. The larvæ gain access to the intestines either through the mouth or through the skin. It is evident, therefore, that two of the necessary preventative measures are cleanliness on the part of the worker, and the isolation of those who are affected by the disease. But besides these it will be evident that the better the mine is ventilated the less favourable will be the conditions for the development of the worm. If the mine is ventilated with a view to keeping it not only cool but also dry, this will prove to be one of the most effective checks on the possible development of an insidious and dread disease.

EFFECT OF THE VOLUME OF AIR CIRCULATED.—If the air-current in a mine were sluggish it would very soon attain the temperature of the rock-strata. In addition, heat would be derived from the oxidation of the timber and coal. Eventually the temperature of the mine air might exceed that of the rock-strata. Dr. Haldane and Mr. Meachem give instances in both coal and metalliferous mines where the temperature of the air in the working places exceeded that due to the depth from the surface. In one case, in a coal mine, the air temperature at the inbye end of the intake airway, that is, just before the air entered the working faces, was 18°F above the rock temperature. In such cases, too, the wet-bulb temperature would in all probability be very little less that the dry-bulb reading, so that the air would be practically saturated. Conditions such as these would inevitably render a deep mine unworkable. The extent to which the air-current will be heated depends not only on the depth and the conductivity of the exposed rocks, but also on the relation between the volume of air circulated in a given time and the extent of rock surface with which the air comes into contact in its passage through the mine. It is also, of course, affected by the difference in temperature between the air and the rock surfaces. If the air is much cooler than the rock surface the flow of heat from the latter into the air will be rapid, while if the difference is slight the transference will be correspondingly slower. Air is, however, a bad conductor of heat, and although the propagation of heat throughout the body of the air-current is assisted by the eddyings and cross-currents in the galleries, the heating-up process is a relatively slow one. Consequently, if the motion of the air is at all rapid, the rise of temperature is comparatively slow.

In modern collieries and in large metalliferous mines the velocity of the air in the shafts and main airways may by anything from 1,000 to 1,500 ft. per minute. At this speed the air would traverse a mile of roadway in from 4 to 5 minutes. For this reason the temperature of the air in the downcast shaft and in the main intake airways of a large well-ventilated mine increases very slowly, and indeed, in some cases, may be said to be practically independent of the rock temperature. A somewhat different condition of things exists in the branch roads and at the working face. There the velocity is much less, from, say, 500 ft. per minute down to as slow a speed as 100 ft. per minute, or even less. The time taken to traverse a given distance is, of course, proportionally greater, and consequently for the same distance travelled the rise of temperature of the air at the working face is very much greater than in the shaft or main airways.

A comparison of this kind can only be proper, of course, if similar conditions prevail throughout. In practice this is not the case, although it has been necessary to assume like conditions in order to emphasize the obvious point that the rise of temperature is dependent very largely on the velocity of flow of the air-current. But it must be borne in mind that the rate of transference of heat from the rock-strata to the air depends on the difference of temperature between the two. The greater the difference of temperature the more rapid will be the flow of heat from the warmer to the colder material. If the temperature of the air entering the downcast shaft is under 50°F, as will in general be the case in temperate regions during the greater part of the year, the difference between the rock temperature and the air temperature in the main galleries leading from the bottom of a deep shaft will be considerable. Hence, although the flow is rapid, the transference of heat will also be rapid. By the time the air reaches the working places, however, it will have warmed up considerably so that the rate of transference of heat from the rock surfaces to the air will be considerably diminished as the result of the smaller difference in temperature between the two.

Again, there is the heating effect of compression in the downcast shaft contributing to the rise of temperature there. Against this there is the lowering of the temperature due to the evaporation of moisture. All of those influences are, of course, in simultaneous operation. Nevertheless the fact remains that one of the chief factors in the rate of increase of air temperature in the mine is the velocity of flow of the air. So much is this the case that if the air-current is sluggish its temperature in the stopes of metal mines will practically always approximate closely to that of the surrounding rocks, and in coal mines the air may be much warmer than the strata. On the other hand, if the air is kept moving at a relatively high velocity, it may emerge from the last working place at a temperature much below the rock temperature.

The velocity of the air-current for a given size of shafts and galleries depends, of course, on the volume of air in circulation. But it is quite possible to have a relatively large volume of air passing into the mine and yet the motion of the air in the stopes, levels, and working places be slow. The course of the air must be confined to as few paths as possible, and leakage should be reduced to a minimum. In many mines, both coal and metalliferous, small auxiliary fans placed underground have been found of considerable benefit in accelerating an otherwise sluggish air-current. It is certain that the use of such fans will be greatly extended as mines become deeper and hotter.

Another point, that should not be lost sight of, is the cooling effect on the workman himself. In a relatively warm atmosphere the cooling effect on the body will depend upon (*a*) the actual temperature of the air, (*b*) its humidity, and (*c*) its velocity. Other things being equal, therefore, the cooling effect of the air on the workman is proportional to its velocity.

THE EFFICIENT VENTILATION OF A MINE.—From what has been said it is clear that the circulation of very large volumes of air is essential to the adequate ventilation of deep and hot mines. It goes without saying that a mechanical ventilator of the centrifugal type must be used. Since it is probable that relatively high water-gauges will be necessary, the type of fan having the vanes or blades curved forward in the direction of rotation will be preferable, other things being equal, as with it higher water-gauges are obtained for a given peripheral speed than with other types. The writer hopes in a subsequent article to discuss the chief features of modern mine fans.

The volume of air circulated in a mine is directly proportional to the square root of the water-gauge. Thus, in order to double the quantity circulating in a given mine, the water-gauge would have to be increased four times. Moreover, the power expended in circulating the air varies as the cube of the volume, so that in order to double the quantity in circulation the horse power of the ventilator will have to be increased eight times. Now it is quite possible that, in a deep mine, the quantity of air necessary for adequate ventilation might be twice, three, or even four times as much as for a shallow mine of the same extent and employing the same number of underground workmen. The power expended in ventilating the deep mine would therefore be eight, twenty-seven, or sixty-four times that necessary for the shallow one. It is therefore conceivable that the cost of ventilating a deep mine might become a serious question.

There are, however, fortunately other devices by the employment of which increase of quantity may be obtained with little or no increase in the power expended.

For a given ventilating pressure, the quantity circulated in a mine is proportional to the square root of the fifth power of the diameter of the airway. Thus a 20 ft. diameter shaft would pass rather more than $5\frac{1}{2}$ times the quantity of air that would pass through a 10 ft. diameter shaft with the same ventilating pressure in each case. Or, again, a shaft $13\frac{1}{2}$ ft. diameter would pass twice the quantity of air that a 10 ft. diameter shaft would pass. The best size of shaft for the very deep mine will have to be considered from the point of view of the ventilation requirements as well as those of output, expense, and convenience. The same advantage is, of course, secured from increased size whatever the shape of the shaft or gallery, and although it costs more to make and maintain large shafts and large main intake airways, it will be necessary to do so in the case of large and deep mines in which the volume of air to be kept in circulation is great. For it must be kept in mind that in many cases all the air has to pass down one shaft and up another shaft, and if the shafts are inadequate in size, the expense of ventilating the mine will be greatly increased. A similar remark applies to the main airways, though not quite with the same force, for splitting the air-current at the shaft bottom tends to relieve the pressure there. The branch airways may of course be much smaller, as the quantity of air flowing in them is considerably less than in the main or trunk airways. These will continue to be proportioned primarily to suit the haulage and travelling requirements. In most cases the proportions will also be adequate to ventilation requirements. Indeed, it may be said that all intake airways, being almost invariably haulage roads, will for that very reason be sufficient in size for ventilation purposes. It is chiefly the return airways to which attention will have to be directed. There the necessity for size for haulage purposes is in general absent, and in consequence the galleries are very often considerably smaller than the corresponding intakes. From the point of view of economical and adequate ventilation it is just as necessary that the return airways be commodious as the intakes. The passages of the mine both from and toward the shafts should be designed so that the demands of ventilation can be met in the most efficient manner.

The Coal Mines Act requires the provision of two main intake airways in mines opened since 1911. At the Bentley Colliery, near Doncaster, the workings are divided into six main districts each of which is provided with two main intake and two main return airways. There are no air-crossings, the return airways being carried upwards into higher strata as they approach the main intakes. In this way leakage is practically eliminated and the efficiency of the ventilation greatly improved.

Of course, after all, the whole question resolves itself into one of cost. For each mine there will be a particular dimension of roadway which will prove the most suitable. It may sometimes pay better to adopt somewhat smaller galleries, and incur heavier running costs for ventilation, than to make and maintain larger airways for a slight saving in the expenditure on ventilating plant. All that we wish to emphasize is that as mines get deeper it becomes more and more necessary that in deciding the proportions of the shafts and trunk airways the requirements of ventilation should be kept prominently in view.

SPLITTING THE AIR-CURRENTS.—One of the most effective means of increasing the total quantity of air circulating in the mine is by judicious "splitting." On this system, which has long been employed in mining, the air-current is divided into a number of portions or splits, each of which traverses independently a separate portion of the workings. Fig. 4 shows diagrammatically how splitting is carried out. If any one of the splits is getting more than its proper share of the ventilation it is regulated by restricting either the inlet or the exit as at R. In this way the quantity of air circulating in each split is adjusted to the requirements.

It can be shown that if each split offers the same resistance to the flow of air and all are subjected to the same ventilating pressure, assumed to be maintained constant, the total volume of air circulated is directly proportional to the number of splits. Indeed, since the aggregate lengths of the several splits may not exceed by much the distance travelled by the air if it traversed the whole extent of the workings in one continuous stream, the quantity of air circulated may increase at a greater rate than the number of splits. On the other hand, increase of quantity due to splitting involves a greater pressure loss in the shafts, and this of course counteracts to some extent the advan-

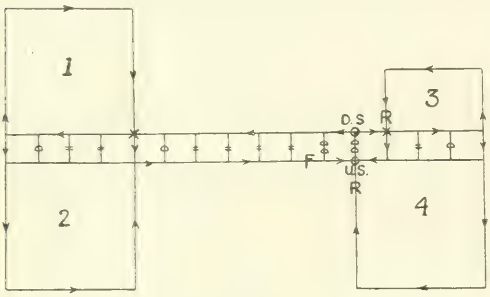


Fig. 4.

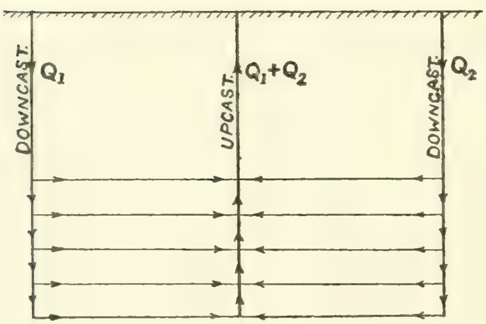


Fig. 5.

tage gained by splitting. On the whole, therefore, it may be said that within limits the increase of ventilating current is co-extensive with the increase in the number of splits.

In planning the deep mines of the future it will be necessary to devise a system in which the advantages to be gained from splitting will be exploited to the fullest extent. The chief points to be kept in mind are:

(*1*) The splits should commence at or as near as possible to the bottom of the downcast shaft. In metalliferous mines and in coal mines having one or more intermediate mouthings, splitting may take place at different points in the shaft itself (see Fig. 5). This is all to the good from the ventilation point of view. Even where it is preferred to have only one loading level, as is usual in coal mining, it may increase the efficiency of the ventilation to air the various seams directly from the downcast and upcast shafts.

(*2*) Similarly the splits should end at or as near as possible to the upcast shaft.

(*3*) The splits should be kept as nearly equal as possible, for regulation always reduces the total quantity of air circulating in the mine.

(*4*) Since for a given depth the rise of temperature of the air-current is approximately a function of the time it is in contact with the rock-surfaces, the splitting should be adjusted so that air going to different parts of the mine and leaving the downcast shaft at the same time should reach the upcast shaft as nearly as possible at the same instant.

In Fig. 4 we have the hypothetical plan of a mine ventilated by four splits, two of which, 1 and 2, are equal. The quantity of air flowing in those will be the same. Splits 3 and 4 are unequal splits, unequal with respect to each other and with respect to the two equal splits Split 4 is of the same dimensions as splits 1 and 2, but it is nearer to the shafts. Hence if the quantity of air required in it is to be the same as that in the two equal splits it will have to be regulated, as at R. Again, split 3 is shorter than 4 and equally near the shafts. Hence if its ventilating current is to be the same as that in 4 it will have to be regulated to a greater extent than the latter, that is, the additional resistance introduced into split 3 must be greater than that placed in 4. Further, since 3 is shorter than the others, it will probably require less air than the others, and the resistance of the regulator will have to be still further increased.

It may often be better, instead of regulating the shorter splits, to install auxiliary fans in those districts which are more remote from the shafts or which require larger quantities of air. Thus in Fig. 4 it might be advisable to place an underground fan at F to aid the current ventilating 1 and 2. In this way it might be possible to do without the regulator on split 3.

Fig. 5 shows a case of vertical splitting such as is practised in metalliferous mines, and sometimes to a smaller extent in coal mines where more than one coal seam is being worked at one time. There are two similar downcast shafts and a central upcast. The air in each downcast is split into five portions at different levels in the shafts. The quantities flowing in the various splits may have to be regulated in amount, since, other things being equal, those splits which branch off first will naturally get a larger quantity than those deeper down.

In order to carry out this last proviso, the actual velocity of the currents in the several splits would have to be regulated so as to vary in inverse ratio to the distance the air had to travel. The shorter the distance travelled the slower the velocity.

The check on the state of the mine air would be the hygrometer. This instrument would be hung in the intakes and returns of the several splits, and readings taken every day. If the wet-bulb temperature in any district exceeded the permissible temperature—say 70° or 75°F —the ventilation of that section would have to be increased or the humidity reduced in some other way.

In this connection mention should be made of the kata-thermometer designed by Dr. Leonard Hill. This instrument not only takes into consideration the temperature and humidity of the air but also the cooling effect due to its motion. It thus translates the physiological temperature condition of the atmosphere into a single numerical result.

The quantity circulating in the various ventilating districts should be measured at regular intervals, and if the aggregate of the several currents does not approximate fairly closely to the quantity metered in the shaft or trunk airways, inspection of the various stoppings and separation doors should be carried out to see if leakage is taking place.

THE PREVENTION OF LEAKAGE.—It is notorious that in many mines a very large proportion of the air never reaches the working places. It is recorded that in one instance—in a coal mine—only 20% of the total volume of air passing down the downcast shaft reached the working face. This is, of course, quite an exceptional case, but it is safe to say that in many mines, both coal and metal, little more that half of the air serves its proper function, which is to cool and purify those parts of the mine in which men have to work and pass. It goes without saying therefore that close attention will have to be paid to the effective guidance and control of the air-current in the ventilation of deep mines. The tendency to leakage will be all the greater in deep mines for the reason that owing to the large quantity in circulation the difference of ventilating pressure between the intake and return airways will be considerably more than is general in present-day practice. It is good practice, however, to keep the ventilating pressure as low as possible by taking full advantage of splitting and maintaining airways of ample proportions.

In metalliferous mines the shafts and stopes are often so arranged that the natural path of the air is through the various levels, stopes, etc., which lie between the downcast and upcast shafts. In those cases it is not difficult to confine the air to the proper route. But in practically all coal mines and, to a greater or lesser extent in most metal mines, the workings are situated remote from either the downcast or upcast shafts. Consequently there is always a strong tendency for the air to short-circuit from the intake airways to the returns, and so never reach the working places. This can only be avoided by carefully blocking all unnecessary paths by air-tight stoppings and by deputing to competent officials the important task of maintaining all doors, pipes, brattices, etc., in such a condition that the maximum possible proportion of the ventilating current will reach the working face. Air-crossings, stoppings, and separation doors should be frequently examined, report made as to their condition, and any necessary repairs promptly executed.

THE EFFECT OF CLIMATE.—It will be obvious that the temperature attained by the mine air will to a greater or lesser extent be influenced by the prevailing climatic conditions. If the air entering the mine is cold it will take a longer time to reach rock temperature than if it is warm before it enters. Indeed, in midsummer, even in temperate regions, the temperature of the air at the surface may be as high as the rock temperature in the workings. In very deep mines, however, those having a rock temperature of 90°F to 120°F, the surface temperature, even on the hottest days, will generally be well below that of the mine. In such a mine, unless the air-current is sluggish, the mine-air temperature on a cold winter's day may be appreciably lower than on a hot day in summer. But a factor which exercises a much more potent influence on the underground conditions is the humidity of the climate. For the same surface temperature, air which is relatively dry will be much more effective in cooling the mine than the same air in a wet or saturated condition.

This fact is the basis of the system of ventilation to be carried out at the City Deep mine, as outlined by Mr. E. H. Clifford in a communication to the Institution of Mining Engineers. The City Deep mine is one of the largest and deepest of the mines of the Rand. The workings at present are at a depth of 4,500 ft. from the surface, and it is hoped that a depth of 7,000 ft. will be reached with comfort. The rock temperature at this depth will be between 95°F and 100°F. It is hoped, however, to keep the maximum temperature in the workings down to 75°F by circulating a sufficiently vigorous current of air. The volume mentioned is 400,000 cubic feet per minute. To attain the desired end, reliance is placed chiefly on the heat-absorbing capacity of the air-current due to its evaporative power. The air in the Transvaal is very dry. The humidity in the winter is only 36%, and even in the rainy season the saturation is only 74%. In this respect the mining engineer in South Africa is more fortunate than his brother in the homeland.

The air entering the mines of the Rand is therefore always in a condition in which it can absorb more moisture, and as it heats up in its passage through the mine its evaporative power increases. In the mine in question there is abundant moisture everywhere for the exercise of this power. As a consequence the cooling effect is remarkable. The plan to be adopted is to keep the downcast shafts as dry as possible to allow the air to absorb moisture freely in the intake airways and stopes. It is best to take the air by the shortest possible route to the deepest part of the mine, and then allow it to rise toward the upcast shafts. In this way, if the air is sufficiently cool and dry in the deepest part, it is likely to remain so in the upper parts, since the dynamic cooling of de-compression as the air ascends will tend to prevent any further rise of temperature.

In short, the system consists in circulating a large volume of relatively dry air and so regulating its distribution, its course, and the supply of moisture that every part of the workings will be kept in a fit state for the prosecution of hard work.

Unfortunately, the climatic conditions in this country are not nearly so favourable as in South Africa. For one thing the temperature gradient is more rapid here than there. In Cornwall, for instance, the rock temperature at 7,000 ft. deep would be probably somewhere in the region of 120°F, as compared with barely 100°F on the Rand; while in the coalfields it would probably approach 150°F (see Fig. 2). Moreover, our climate is a more humid one, and in consequence the drying power of the air is considerably less than that of the air in the Transvaal. In addition, in coal mines, we have the heating effects due to the oxidation of coal which, as has been seen, contributes greatly to the rise of temperature.

The Government Commission already referred to state that "with adequate and properly-planned ventilation there would seem to be no reason to doubt that in this country at least, or in a fairly dry or fairly cool climate, the wet-bulb temperature can, by ventilation alone, be sufficiently controlled to make work economically possible at any depth at present in contemplation and up to at least 5,000 feet."

ARTIFICIAL DRYING AND COOLING OF THE AIR.—We have shown that in most coal-mining areas it will be practicable to carry exploitation on economical lines down to depths of at least 5,000 ft., and in metalliferous areas, such as South Africa and many of the American metal-mining regions, to much greater depths with the ordinary methods of ventilation. Beyond those depths and in special cases it will be necessary to artificially dry and cool the air entering the mine. This may be accomplished in two ways: (*a*) by employing refrigerating plant, (*b*) by the aid of compressed air.

In the former method the cooling effect is produced by the evaporation of ammonia from the liquid to the gaseous condition. The ammonia is compressed and cooled to liquifaction in a condenser. It then passes through a reducing valve which enables it to return to the gaseous condition under approximately atmospheric pressure. The evaporation is accelerated by the gas having to pass through a spiral immersed in a brine consisting of a solution of calcium chloride. The brine is thus cooled well below the freezing point of water, since the heat necessary to evaporate the ammonia is taken from the brine solution. If, now, the brine is caused to flow through a series of tubes and the air entering the mine has to circulate among the pipes before it passes into the downcast shaft, the result will be a considerable lowering of temperature. At the same time a large amount of moisture will be deposited. In this way the air for ventilation purposes will commence its journey cool, and containing relatively little water, an ideal condition for the requirements of deep mining. Carbonic acid, or sulphurous acid gas, may be used in lieu of ammonia.

A refrigerating plant has recently been erected at the Morro Velho gold mine, owned by the St. John del Rey Mining Company, Ltd. The mine is situated in the State of Minas Geraes, Brazil. It is at present one of the deepest mines in the world, the lowest workings being 6,600 feet vertically below the outcrop, and 3,650 feet below sea level. The plant was manufactured mainly by Messrs. J. & E. Hall, Ltd., of Dartford. It is capable of reducing 80,000 cubic feet of air per minute (which is the quantity of air in circulation) from an initial wet-bulb temperature of 72° F to 43·5° F, which is considered a sufficient amount of cooling. In order to be capable of adjustment to the varying climatic conditions throughout the year, the plant is divided into six stages, each complete with its own motor-driven ammonia compressor, condenser, and evaporator, so that the sets can be run singly or in groups. The air-cooling will be accomplished indirectly, the ammonia plant being used to cool water, which in turn cools the air as it passes through two large Heenan air-coolers.*

The second method consists in utilizing the well-known cooling effects resulting from the expansion of compressed air. For example, compressed air at 45 lb. per square inch gauge pressure and an initial temperature of 70°F will attain a final temperature, after expansion down to atmospheric pressure, of approximately minus 100°F, that is, a fall of 170°F. The actual reduction of temperature produced in this way depends on (1) the initial pressure, (2) the degree of expansion, and (3) the closeness of the approximation to adiabatic expansion. In rock-drills and other compressed-air machinery, the expansive properties of the air are either not utilized at all or are used only to a limited extent, so that the temperature of the exhaust air is nothing like so low as that reached when complete expansion is carried out. The low temperatures produced by expansion can only be secured if the air is made to do work during the expansion. If the pressure air is allowed to escape into the atmosphere without performing work in the process, only a very slight fall of temperature results. It is not practicable to adopt a high degree of expansion either in drills or coal-cutters, and if it is desired in any case to utilize the cooling effects of compressed air, the expansion would have to be carried out in a special machine under conditions admitting a high degree of expansion. The compression of air is a costly process, and this fact will prove a deterrent to its use for cooling the atmosphere of mines. On the whole, mining engineers at present favour the view that the mine air may be cooled and dried more cheaply on the refrigeration system than by compressed air. In a recent paper on the subject† Mr. S. F. Walker states that a plant of rather more than 1,000 tons of refrigeration would be required to cool 100,000 cubic ft. of air per minute from 85°F (dry) and 80°F (wet) — humidity 80% — through 10°F, and to absorb the latent heat of the water deposited in the cooling. This would mean a plant of fully 1,000 h.p.

It should be remembered that if compressed air were used for cooling, only a small proportion of the ventilating current would have to be compressed, certainly not more than 10%, for a reduction in temperature of 10°F. Thus, if the total volume of air in circulation were 100,000 cu. ft. per minute the amount to be compressed would be not more than 10,000 cu. ft. per minute.

With either method, under a well-devised ventilation system, the artificial cooling would probably require to be used only during the hottest part of the year.

* Trans. Inst. Min. Eng. Vol. lviii., p. 244.

† *Iron & Coal Trades Review*, Nov. 8, 1918.

LETTERS TO THE EDITOR

Professional Qualifications.

The Editor:

Sir—With reference to an editorial comment in a recent issue of the Magazine regarding the somewhat heterogeneous nature of the qualifications which may be implied by membership of the Institution of Mining and Metallurgy, I should like to draw attention to a similar matter which has doubtless struck other mining geologists besides myself. It is the fact that there have recently been elected as members of the Institution quite a number of geologists who have had no mining experience whatever. I take it that most of these gentlemen have no intention of entering into the field of mining geology in a professional capacity, and it is of course obvious that their contributions to the discussion of theoretical questions may be of great value, while their criticisms undoubtedly tend to keep up the standard of the papers submitted dealing with such matters as the genesis of ore deposits. At the same time, it is scarcely fair to the practising mining geologist, who has had to submit his professional qualifications to severe scrutiny before being admitted to membership, that the academic geologist should be elected without any such qualifications, and with nothing to prevent him in the future from using his membership as evidence of fitness to deal with mining problems. Dr. A. W. Rogers, director of the Geological Survey of South Africa, has, within the last few weeks, pointed out in an address delivered at Johannesburg that it is practically impossible for the inexperienced geologist to grapple with the details of mining matters. It would be easy to cite one or two recent prospectuses as very cogent evidence of this.

While on the subject of the Institution, I may perhaps draw attention to another matter which seems worth attention. It will be clear to any mining man who reads prospectuses that the internal evidence of the reports attached thereto is often quite sufficient to show the incompetence of the writers. When an "engineer" reports on a property with a poor milling record, and accounts for lack of ore at the bottom as due to a "local zone of impoverishment," or relies for his valuation on samples which he is "informed" or "understands" went so many per cent or ounces, over so many feet or inches, as the case may be, it seems high time the Institution took some drastic steps to prevent such documents from being used to extract money from the public, or obtained powers to do so if it does not already possess them.

F. P. MENNELL.

Northern Rhodesia, April 26.

[We refer to this letter elsewhere in this issue in the account of the annual dinner of the old students of the Royal School of Mines.—EDITOR.]

Hematites of South Wales.

The Editor:

Sir—In the February issue of the Magazine there is a review, by Mr. J. D. Kendall, of the Memoir of the Geological Survey, Vol. X., "The Hematites of the Forest of Dean and South Wales," of which Professor T. F. Sibly is the author. In this review (page 126, at the top of the right-hand column), Mr. Kendall refers to an interesting geological feature in the old Mwyndy and Bute iron ore mines, which are in the neighbourhood of Llantrissant, Glamorganshire. This feature is that the Keuper conglomerate, which lies horizontally and unconformably on the coal shales terminates, at its southern limit, when it reaches the line of contact between the shales and Carboniferous limestone, as shown in the transverse section, Fig. A (reproduced herewith from Mr. Kendall's review). This section, and one or two others of a similar character, first appeared in connection with a short paper on "The Hematite Deposits of South Wales," which I read before the South Wales Institute of Engineers in 1885. Mr. Kendall suggests that these drawings lack completeness, inasmuch as they do not afford an explanation of the feature referred to. He says he cannot "understand how the conglomerate could rest on the ore, as shown, without the intervention of a fault, coincident with the contact of the ore and the overlying rocks." If there can be found reasonable evidence of a fault at this contact, it should, of course, be shown in any drawings of these places, but though I was associated for some years, prior to 1885, with one of these mines when at work, I am unable to recall any appearance suggestive of a fault at the contact. It is a long time to look back for the purpose of recalling appearances, and for that reason, perhaps, I should be prepared to admit the possibility of a fault, particularly having regard to the fact that, if existent, it would have shale as one of its walls, and that it, therefore, might not be easily detected. I would, however, venture to suggest another possible explanation. Might not an erosion have occurred prior to the deposition of the conglomerate, which eroded the soft shale to a lower level than it did the limestone?

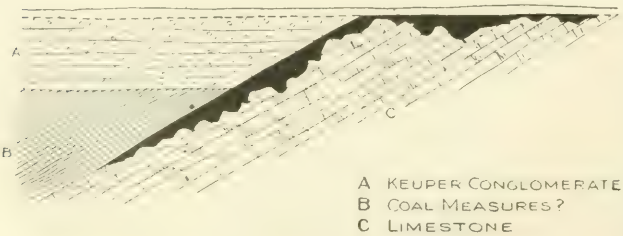


FIG. A, FROM J. D. KENDALL'S REVIEW.

Leaving this purely technical question, however, a much more important matter, from a practical point of view, is suggested to my mind by a perusal of Professor Sibly's Memoir. In the transverse section, Fig. 10, page 69 (reproduced opposite), he gives what he terms a "generalized section east of the main shafts." In this he shows that the shale, hematite, and limestone are cut off to the dip (northward) by a fault, apparently running east and west. If this section correctly interprets the conditions there must be, to the north of this ground, a duplication of the contact between the shale and the limestone, with every probability of a further deposit of hematite between them. It would certainly be worth the expense of testing the northern ground, either by prospecting from the surface or by driving underground from the existing workings.

This portion of Professor Sibly's Memoir, referring to the Llanharry property, has a special interest to me, inasmuch as the hematite deposits there were discovered by my father, the late William Vivian, under conditions of great difficulty, and with a good deal of adverse criticism during the earlier prospecting. The deposits have, as is shown in the section, a very considerable covering of gravel and conglomerate, the former, at the place where the hematite was first discovered, reaching to a depth of over 120 ft. This work was carried out, I think, in the years 1873 and 1874, and a diamond rock-boring plant was employed, possibly for the first time in this country for mineral prospecting purposes. For reasons which need not be entered into here, the deposits at this particular place (which I think was locally known as "Tynant" in those days) were not then won by shaft-sinking. The strike of the contact between the shale and the limestone (and therefore the line of the hematite deposits) having by this discovery been ascertained, borings were made farther eastward, and, other good deposits having been found, they were successfully mined, until the growing competition of the Bilbao supplies rendered it impossible to continue remuneratively, and the work was suspended in 1892.

STEPHEN VIVIAN.

London, May 20.

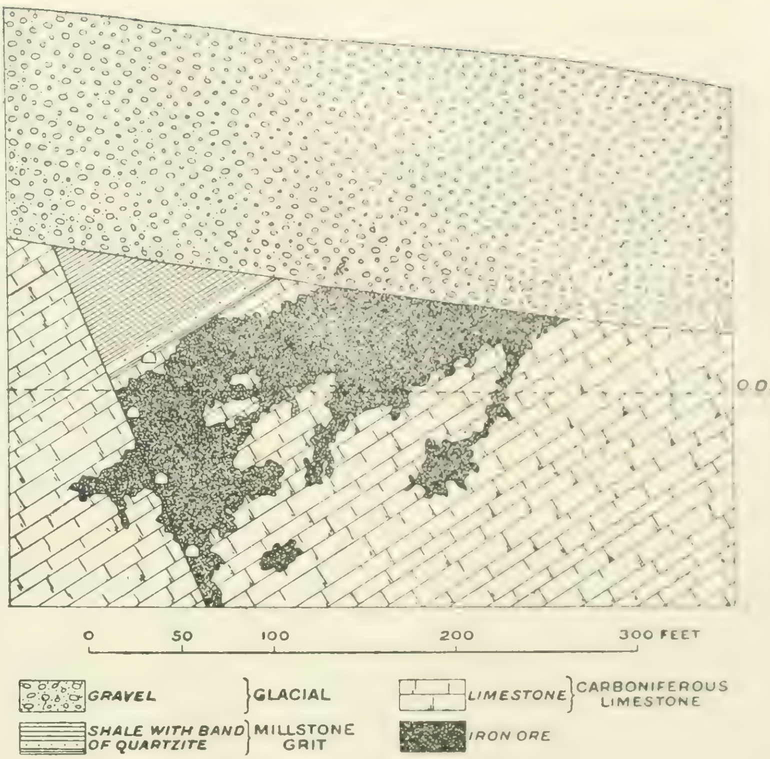


FIG. 10 OF DR. SIBLY'S MEMOIR.

NEWS LETTERS.

VICTORIA, B.C.

MINING LEGISLATION.—During the session of the Provincial Legislature, which has just closed, a considerable amount of legislation relative to the mining industry has been enacted. An amendment to the Placer-Mining Act, which comes into force on July 1, 1920, provides as follows: (a) Annual rental for bench lease \$25, and development work to the amount of \$250; (b) annual rental for creek lease \$37·50, and development work to the amount of \$250; (c) annual rental for dredging lease \$25, and development work to the amount of \$1,000. The lessee may pay the mining recorder the amount for the development work required instead of performing the work. In the event of failure to fulfil these conditions the lease becomes automatically forfeited. Work in excess of that demanded in any year may be applied to future years up to three years, but not more. Existing leases may be brought under the new law, thus reducing annual rental and assessment work, or they may be left in stato quo.

Coal-mining lands in the Province have been withdrawn from location by an order of the Lieutenant-Governor in Council, and, by an amendment to the Mineral Act, iron lands may be withdrawn from location by a single notice in the *British Columbia Gazette*. Lands so withdrawn may be disposed of by the Lieutenant-Governor in Council after publication for 60 days in the *Gazette*. The purported object of the withdrawal of coal and iron lands from location is to prevent them being held indefinitely for speculative purposes without any work being performed on them.

An Act to incorporate the Association of Professional Engineers in the Province of British Columbia, which does not come into effect until April 1, 1921, restricts the practice of engineering to members of the association. The mining men throughout the Province opposed the bill vigorously, and consequently a number of exceptions have been made, which are too lengthy to enter into here. It is likely, too, that further alterations may be made at the next session of the Legislature, if, indeed, the Act is not entirely rescinded.

DOLLY VARDEN.—An Act respecting the Taylor Engineering Company, Limited, which was rushed through the House in the last 24 hours of the session as a Government measure, has caused adverse criticism from one end of the Dominion to the other, and, at the time of writing there seems to be every prospect that the Federal Department of Justice will disallow the Act. In the 1919 session, the Dolly Varden Mines Railway Amendment Act was passed, by which, after an inquiry into the expenditures of the Dolly Varden Mines Co. in the purchase and development of the mine, and of the Taylor Engineering Co. in the building of a railway from Alice Arm to the Dolly Varden mine, by a judge of the British Columbia Supreme Court, the Dolly Varden company was given the option of either paying the Taylor company for the railway, which it had ordered, or allowing the Taylor company to take over the mine and pay it the money that had been expended in purchase and development out of profits from the mine. There were several other provisions. The Federal Department of Justice had one year, or until April 11, 1920, to disallow this Act. The Dolly Varden company failed to make payment to the Taylor company within the specified time, and on June 10, 1919, the Taylor company took over the mine. The Taylor company completed the railway, built an aerial tramway, and started to ship ore by September 1. Between then and December 15, when the railway was closed by snow, the Taylor company shipped 6,373 tons of ore containing 400,336 oz. of silver. Since the closing of the railway they have shipped out another 100,000 oz. of silver in the form of high-grade ore, running from 1,000 to 2,500 oz. per ton, by dog sled. The Federal Department of Justice did not disallow the Act within the specified time, and the Dolly Varden company started action against the Taylor company and its directors individually for trespass and for the silver that had been taken from the mine. Then followed, in the dying hours of the session, the passing of the Act which reads : " It is hereby declared that all the real and personal property and rights described in the schedule hereto did on May 23, 1919, vest in the Taylor Engineering Company, Ltd., for an estate in fee simple or absolutely, according to the nature thereof, and now is and shall continue to be so vested in the Taylor Engineering Co., Ltd., or its assigns, subject to such of the charges described in the Dolly Varden Mines Railway Act Amendment, 1919, as now remain unsatisfied, and to all obligations incurred since the date of the passing of the Dolly Varden Mines Railway Act Amendment, 1919, and binding the said real and personal property and rights." A schedule giving a list of the real and personal property follows. Thus recourse to the courts has been closed to the Dolly Varden Mines Co., unless the Dominion Department of Justice disallows the Act.

WET MAGNETIC CONCENTRATION AT TRAIL.—After ten years' diligent research, the Consolidated Mining & Smelting Company's metallurgical staff, at Trail, has successfully demonstrated the applicability of two methods of treatment for the dressing of the company's Sullivan mine ore. The one is a modified Minerals Separation process and the other a wet magnetic concentration followed by Wilfley tables.

The Sullivan mine ore is a dense sulphide, containing zinc-blende, marmatite, galena, pyrrhotite, pyrite, and from 3 to 6% of gangue. So closely are these various minerals interblended that often it is possible to distinguish through a powerful microscope two and sometimes more of the minerals in a single grain of ore that has passed through a 200-mesh screen. The company has two plants working on this ore at Trail; the Minerals Separation plant has a capacity of 400 tons per day, and the wet magnetic plant has a capacity of 600 tons per day. Although they are being operated on a commercial scale, these plants are really experimental plants, and upon the results obtained from them during the present year will depend the nature of the 2,500-ton plant that ultimately is to be erected at the Sullivan mine, at Kimberley, B.C.

At the Minerals Separation plant, the ore is crushed to pass a 20-mesh screen, and run over Wilfley tables, which remove from 20 to 25% of the lead content. The tailing is crushed in a ball-mill to pass a 200-mesh screen, and is run through a modification of a Minerals Separation machine, using from 1 to $1\frac{1}{4}$ pounds of a mixture of pine oil and creosote per ton of ore. Other chemicals are being tried from time to time, but no information as to their nature and quantity is available for publication. The machine gives a satisfactory concentrate, which is being used for the electrolytic production of zinc, while the tailing from the zinc plant goes to the lead smelter. It is not considered that the machine has been fully developed yet, and even better results are expected from it.

It has been found that the magnetic properties of the pyrrhotite in the ore can be improved by a preliminary heat treatment. The ore is crushed to pass a 2-in. gauge, and the fine is separated from the coarse on a Mitchell screen ; the coarse is passed through a revolving furnace and heated to a temperature of about 1,000° F ; the fine is carried by a belt-conveyor and is mixed with the coarse as it leaves the furnace. In this way the fine is not over-heated, as it would be if it were passed through the furnace with the coarse. The mixed fine and coarse are passed to an iron drum, the bottom of which is immersed in running water, and the ore is rapidly cooled. This rapid cooling seems to play as important a part in improving the magnetic qualities of the pyrrhotite as the heating, and, further, it has been found that to get the best results it is essential that the cooling should be done in air, and not in water. In fact, cooling in water seems to a great extent to destroy the magnetic properties of the mineral.

The treated ore is ground in a ball-mill, and the pulp is passed over a Dings magnetic separator. This machine was devised to treat the Sullivan mine ore, and is the result of collaboration between the Consolidated company's staff and the engineering staff of the makers of the machine. The machine consists of an endless rubber belt running on rollers, similar to an ordinary vanner belt. Toward the centre of the belt, the two terminals of a horseshoe electro-magnet, excited by a 15 ampere current, are placed right across the width of the belt and about ½ in. above it. Between the main belt and the electro-magnet is a narrow belt, moved by rapidly revolving pulleys, which are placed so as to extend the narrow belt well beyond both the main belt and the magnet.

The pulp is fed evenly on to the main belt, and as it passes under the magnet the magnetic particles are attracted and attached to the under side of the narrow belt, which conveys them out of the magnetic field and drops them into a chute. This conveys them to a ball-mill, where they are re-ground and then passed over the machine again, as in the first passage a considerable amount of galena and blende is removed with the pyrrhotite. The non-magnetic particles pass over the end of the main belt and are conveyed to Wilfley tables, where as much of the galena is separated from the blende and marmatite as is possible. The concentrate contains from 25 to 30% of zinc and from 12 to 15% of lead. It is roasted and used for the electrolytic production of zinc, while the tailing from the zinc works is used for the production of lead and silver.

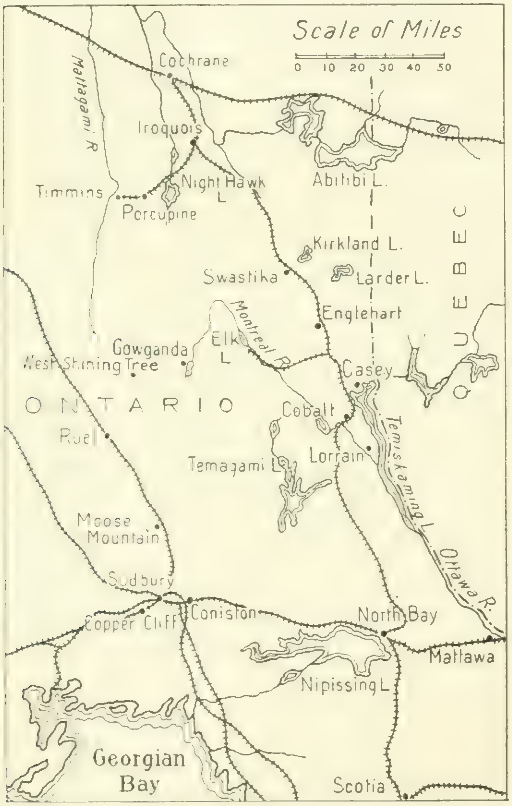
Pyrite, which sometimes forms a considerable part of the ore, is not removed to any appreciable extent either by the magnetic separator or the table, nor, as a matter of fact, is the small amount of gangue appreciably reduced by the treatment. The pyrrhotite is eliminated almost entirely, and usually this is the principal unprofitable mineral in the ore. At the time of my visit to the plant, both machines were doing good work, and no one would venture to guess which type of machine ultimately would be chosen for the big plant. It is not impossible that it may yet be a combination of both.

TORONTO.

May 11.

KIRKLAND LAKE.—There is great activity in this district, and many new enterprises are being undertaken, especially to the eastward of the proved gold-bearing zone. The Tough-Oakes has arranged to resume mining operations on May 20. The mill will be overhauled and a new ball-mill installed, with the intention of starting up work early in July. The merger of the Tough-Oakes with the Aladdin Cobalt, which controls the Burnside, has been completed. Ore now in sight on the Tough-Oakes and Burnside is estimated as upwards of 17,000 tons, averaging over $12 per ton. The Ontario Kirkland has opened up two important ore-shoots on the 300 ft. level, one of which shows an average gold content of about $20 per ton for a distance of 100 ft. The shaft has been put down to 450 ft. where a level will be run to tap these ore-bodies. Should the results of development at depth prove satisfactory, the company will erect a mill. The Hunton-Kirkland is being reopened, the capital to finance development having been secured by the sale of treasury stock. H. M. Porteous, formerly manager of the Vipond North Thompson, has been appointed manager. The Elliott-Kirkland, on which a shaft was sunk to 500 ft. with only meagre results, will continue sinking to the 700 ft. level, exploration by diamond-drilling having indicated greater possibilities at that depth. The Kirkland Lake management has decided to develop the western half of the property by driving at the 500 ft. level for about 600 ft. to the western boundary. An extensive ore-shoot is being opened up at the 300 ft. level. The Wright-Hargreaves has resumed operations. Machinery for the new mill of 150 tons is now on the ground. The Lake Shore during March treated 1,682 tons of ore for a yield of $45·133, being an average of $26·85 per ton.

PORCUPINE.—Notwithstanding the recent increase in the scale of wages, bringing the rate practically equal to that paid by the silver mines, there are still complaints of a labour shortage, which, though not serious, is sufficiently pronounced to prevent the companies from materially enlarging the scope of their operations. The large producing mines are steadily maintaining their output and realizing satisfactory profits, and the prospects are favourable for the continuation of dividend disbursements about as at present. At the Davidson the drift on the vein at the 500 ft. level has been run for 460 ft., the width of the vein varying from 27 to 53 ft. of ore of good commercial grade. The North Davidson is making arrangements to start work on an extensive scale. A mining plant is being installed and electric power secured. The Clifton Porcupine is driving at the 200 ft. level, and has a good tonnage of ore in sight. The Sovereign, Gold Reef, and Hayden-Porcupine companies are planning to resume operations.



MAP SHOWING THE METAL-MINING DISTRICTS OF NORTHERN ONTARIO

COBALT.—Owing to the decline in the price of silver, the larger producing mines have latterly been storing their bullion in the hope of a rise. With the decline in silver, the bonus paid to the miners, based on the silver market, has also been reduced. The companies are having some difficulty in maintaining full working forces, the supply of labour not being adequate to the demand, in which respect the mining industry suffers in common with nearly every branch of industrial enterprise, labour shortage being a universal complaint. The Beaver Consolidated has leased the Prince property adjoining, and is now negotiating for the Badger adjacent. It is proposed to carry development work into the Prince claim at the 1,400 ft. level from the lowest workings of the Beaver, and subsequently to extend this work to the Badger. The annual report of the Mining Corporation of Canada shows a total production of 1,230,652 oz. of silver, with net profits of $908,748, as compared with 1,708,252 oz. produced and net profits of $925,760 in 1918. Ore reserves amounted to 1,307,220 oz., as compared with 1,240,550 oz. The report of the consulting engineer, Scott Turner, showed that the investigations of the company had covered a wide field, but very few properties were acquired. Active exploration of the radium ore deposits in Butt Township, Northern Ontario, was recommended. The Nipissing during April mined ore of an estimated value of $364,258, but made no shipments. During the first four months of 1920, production amounted to $1,501,571, a rate far exceeding that of any previous similar period. The cost of production during 1919 was reduced to a little over 35 c. per oz., which is claimed to be the lowest for any silver mine in the world. The Peterson Lake has made an agreement with the Dominion Reduction Co. for the treatment of its slimes, of which there is an accumulation of between 300,000 and 400,000 tons. The Reduction Co. is to receive one-third of the proceeds. The production of the Kerr Lake for April shows a large decrease, being approximately 61,000 oz. compared with 99,400 oz. in March. This is believed to be due to the depletion of the higher-grade ore-shoots. The merger of the Bailey and the Northern Customs Concentrator under the name of the Bailey Silver Mines, Ltd., has been completed, with A. J. Young as president. The ore developed at the Bailey, which has been closed down on account of litigation since 1914, is estimated at 23,186 tons with a silver content of 510,294 oz.

BOSTON CREEK.—Electric power has been turned on at the Miller Independence, where the central shaft has been completed to a depth of 500 ft. At the Peerless a good vein has been opened up at the 250 ft. level.

LIGHT RAILWAYS FOR THE MINING DISTRICTS.—The Canadian Light Railway Construction Co. has obtained a charter from the Ontario Legislature for the building of light narrow-gauge railways to open up the outlying mining districts, and work will be commenced immediately on the line from Elk Lake to Gowganda, which it is proposed ultimately to extend into the West Shining Tree district. A loop line will also be built east from Swastika to Kirkland Lake, thence south to Larder Lake and Skead Township, and westward to Boston Creek. A branch to Matachewan is also in contemplation. These camps have long been handicapped by transport difficulties, and the railways are expected to give a great stimulus to the mining industry.

MELBOURNE.

March 23.

WATER POWER IN TASMANIA.—In a recent issue of the *Industrial Australian and Mining Standard*, Mr. Hartwell Conder gives some particulars of the Lake Rolleston waterpower project. For several years past, interest in the matter of water-power on the west coast of Tasmania has centred on the King River scheme. This scheme, which involved the erection of a very high dam on the King River about 15 miles from Queenstown, was calculated to provide some 50,000 h.p., and to cost about a million of money. As time went on, it was found that the power to be provided was in excess of the present demand, while the capital required for a scheme of these dimensions was also a stumbling block. In the end, therefore, the King River has been shelved for the present, and recourse has been had to a scheme of smaller dimensions, which possesses certain advantages well suited to the requirements. Mr. Conder, when State Mining Engineer, devoted considerable time and labour to investigating its possibilities, and as it has some special features of its own, a brief description may prove of general interest.

It may be explained that on the west coast of Tasmania, at any considerable elevation, the rainfall, as a rough estimate, may be taken as 100 inches per year. It is considerably more in some of the higher country, and less as you come down in elevation or go farther east away from the coast. The run-off from a square mile receiving this rainfall, if it can be distributed equally for the whole year, will give one horse power for every foot it falls. With a catchment of 15 square miles, and a fall of 1,000 ft., 15,000 h.p. can be secured.

The rainfall is fairly regular for about nine months of the year, but for the first three

MAP ILLUSTRATING THE LAKE ROLLESTON HYDRO-ELECTRIC SCHEME.

months of the new year, and occasionally for other months, it may be extremely low. Since, too, bare rock predominates in much of the mountain country, when the dry weather supervenes, the streams in the briefest time dwindle down to mere trickles of water. As regularity of supply is absolutely essential in power schemes, it will be realized that storage, very ample storage, is the prime factor.

The locale of the present scheme is about 12 miles east of Zeehan, and about 15 miles north of Queenstown. Many of the Tasmanian rivers have a curious characteristic, due to the geological folding of the country. They start on a north or south course, and after proceeding some distance swing round suddenly at right angles, either to the east or west. If one proceeds due east from Zeehan, at about 10 miles out, the gorge of the Henty River is reached, very precipitous and deep. The Henty here runs south, but soon bends round and goes west to the sea. If the Henty is crossed, and the eastern valley scaled for about 1,000 ft., a smaller plateau is reached, which is bounded by considerable mountains, forming part of the west coast range. At one point there is a gap in these mountains, known as Newton Gap, and through this you can slip from the Henty watershed to the valley of the Anthony River, which flows due north to the Murchison, and so to the Pieman River.

The Anthony and Pieman rivers thus run parallel for a considerable distance in opposite directions, separated by the mountain range referred to, broken in the one place by Newton Gap. Years ago the idea was broached of bringing the waters of the Anthony through the Gap, uniting them with the upper waters of the Henty, and using them to develop power 1,000 ft. lower in the Henty valley. In 1914 Mr. Conder was searching for power schemes on the west coast, and looked into these waters. The whole crux was the storage. The Anthony draws its water from Lake Rolleston, which is above the Gap; but Lake Rolleston has a wide flat outlet, apparently on morainal material, and does not seem in any way suitable for a dam site. On the Henty falls there is a flat below Lake Julia, on which a useful dam could be erected for a small scheme; but the catchment here would be small, and by itself it does not appear adequate. After the Anthony leaves Lake Rolleston it flows for some two or three miles through a broad, flat valley, and then narrows down to a gorge through conglomerate rock. After that the fall is rapid for some distance. It was seen that this point was a suitable site for a dam, and a few preliminary surveys showed that, with a dam of moderate height, sufficient storage could be secured to equalize the flow for the year; but this site was below Newton Gap, and the water could not be delivered to the Henty fall, though much of the Henty water could be brought over to the Anthony.

Having secured the requisite storage, the next question was the fall. It was known that there was some 1,500 ft. difference between the level at the dam site and the level of the Pieman River, near Tullah, but the distribution was not known. Surveys promptly showed that a fall of 500 ft. could be secured in about a mile and a half. The catchment was about 10 square miles, with possibilities of increasing this by robbing the Henty; so that here was a nice scheme, with great natural advantages, that would provide 5,000 to 6,000 h.p. The trouble was that, by putting in an easy scheme of these dimensions, if, later, a demand for more power arose, this scheme blocked the utilization of this water with greater fall to develop greater power.

This point was regarded as so important that surveys were carried further down the Anthony River four miles, and then down the Murchison River for six miles. It was found that the Anthony River had a good fall, and that, by the time the Murchison was reached, close on 1,000 ft. of head was available; but, unfortunately, the country between the head race and the river was undulating, and a pipeline of such length would be required that the cost became prohibitive. This was more regrettable in that the country passed through was, for the most part, good for race cutting, while all the time the work was bringing the power station nearer to Rosebery, which was then regarded as the prospective market for the power.

Faced, though, with these difficulties, which, while not insuperable, were adverse factors, the position at Newton Gap was again considered. The top of the Gap was 159 ft. above the bottom of the dam site. On the Anthony side, the ground rose abruptly from a level about 70 ft. above the dam site. On the Henty side it sloped away more gradually. It was found that the tunnel through the Gap, at the 70 ft. level, would be about two-thirds of a mile long. By cutting a channel in the plain, the level could be even further reduced, without increasing excessively the length of the tunnel. This meant, of course, that if the dam was erected the water would need to rise to a height of 70 ft. before any would flow through the tunnel, and that the dam would be required to be raised above this height to give the necessary storage. This was a serious matter, but after weighing the pros and cons, it was decided to carry through the investigations, so that information might be available for both schemes. It was recognized that small subsidiary dams would be needed on Julia Flat, on the Newton Gap Creek, and on Falls Creek, and Julia Flat was carefully surveyed. Search was started for the best site for a pipe-line and power station, and one possible line was cut out and reports gathered in of better lines lower down. Work was proceeding quietly, but steadily, when the Labour Government came into power, and the whole research was closed down. The disappointment ensuing does not need emphasizing. The scheme was attractive, in that it lends itself so readily to gradual expansion. If only 2,000 to 3,000 h.p. was required, that could be secured on the Henty fall alone, by the Julia Flat dam and smaller dams on Newton Gap Creek and the Falls Creek. If more power was required, the tunnel could be driven and the Anthony brought in through it. The upper waters of the Henty could then, by a large short canal—large enough to convey the flood waters—be turned into Julia Flat. Finally, the dam could be erected on the Anthony, and the whole scheme rounded off to its maximum of probably over 20,000 h.p. Even then it might be possible to add to this power by stealing some of the Stitt River watershed and harnessing some of the water on the western side of the Henty River.

The scheme will, however, eventually mature, and should prove of enormous value to the West Coast.

CAMBORNE.

NEW DISCOVERIES.—The gloom overhanging the Cornish tin-mining industry as a whole at the present time has been lightened in two places by what promise to prove really important discoveries; a few months ago the prices of the shares of the companies concerned would have moved up substantially on the news, whereas, at the time of writing, they are less than when the news first became public. At East Pool & Agar, the improvement is at the 190 fm. level east on the Rogers lode. This end was first driven south of the elvan on what now is evident was only a branch of the main lode. To test the ground, a bore-hole was in 1918 put out north, and this intersected the main portion of the Rogers lode, and also the Trembath lode, which courses still further to the north. The management then went back to what was believed to be the main section of the Rogers lode, but, as it continued poor, short cross-cuts were subsequently put out north and south; it is in the latter that good values have been found, 56 lb. of black tin per ton over about five feet. The importance of this discovery lies in the fact that this end in going east into a large section of entirely unexplored ground, and if good values are maintained, the prospects of the Tolgus undertaking, referred to in the last issue, will have risen considerably. At South Crofty, in a cross-cut north from Robinson's shaft at the 290 fm. level, a south-dipping lode, 13 ft. wide, has been intersected. We hear that 10 ft. assays 60 lb. and the other 3 ft. 26 lb. black tin per ton, and as both are well above the milling average, the exploitation of this lode will be watched with great interest. Doubtless, too, the continuation of this lode will be hunted for in East Pool.

NON-FERROUS MINES COMMITTEE REPORT.—We have all along warned our readers not to expect that the tin mines of Cornwall and Devon would secure any immediate financial assistance as a result of the investigation into the industry made by this Committee, and our forecast in this respect proves to be accurate. The investigation made by the Committee was very thorough, and it is clear that the members have fully grasped the considerations which were advanced by representatives of the industry in justification of the demand made for State financial assistance, for they go so far as to set out in their report that it has been strongly impressed upon them that the industry is entitled to special consideration on account of the following reasons:

(1.) The price of tin was depressed by direct Government action, and if the Government had not intervened the price would have reached, and been maintained at, a much higher figure during the later period of the war.

(2.) The price of tin, in consequence of Government action, was depressed to the extent of approximately £100 per ton, with consequent loss to the Cornish tin-mining industry.

(3.) The tin-mining industry in Cornwall did not receive Government assistance similar to that given to certain other industries, nor was its labour protected to the same extent during the war.

(4.) The maintenance of the tin-mining industry is an insurance for supplies in case of emergency.

(5.) In the present state of the exchanges it is to the benefit of the nation that the production of home supplies should be encouraged by every legitimate means.

This being the case, what is the explanation of this colourless report? We notice in a contemporary the reason given is that only one member of the Committee (Mr. R. Arthur Thomas) had any real knowledge of Cornish tin mining. This is incorrect as a statement of fact, and indeed the report proves that the Committee had all the essential information placed before them, and were competent by practical experience to adequately judge the disadvantages under which the industry had been conducted since the war, and also to fully appreciate the possibilities of this wonderful mineralized area and its value to the State. Our own opinion is that the leading members of the Committee were obsessed with the value —and indeed it is a useful suggestion—of the establishment of a Mines Department, and the others had not the vision necessary to propound practical proposals, likely to meet with Treasury approval, which would have helped the industry out of the slough of despond into which it has fallen largely through no fault of its own. For after all, sound as the proposal is to establish a special Mines Department, it will probably need parliamentary sanction, which usually takes some time to secure, unless special facilities are granted by the Government, while the Cornish mining industry wants immediate help in a practical form which will save it from what promises to be an early demise unless the price of tin rises again as quickly as it subsided. Cornwall unfortunately sends to Parliament no member who counts in Government circles—the county is a far cry from Westminster—while the industry has no live organization (we do not overlook the existence of the Cornish Chamber of Mines) to vigorously voice its claims. At the time of the inauguration of the Chamber of Mines, we questioned the policy of having no committee or organization in London which would be nearer the heart of things, but the narrow parochial view prevailed, and now the result of doing things in a half-hearted manner is seen. Government departments are seldom moved except by a clamorous persistence or by influence from inside. We would suggest that a special effort should be now made to secure that a deputation representative of the industry should be received by the Prime Minister, the Chancellor of the Exchequer and the President of the Board of Trade. A deputation to the Board of Trade, as arranged through the Joint Industrial Council, is not sufficient in itself in our opinion ; it does not "carry enough guns." The Prime Minister is a Celt and should therefore be specially concerned with the welfare of his confreres in Cornwall, and if the representations made are persistent and dramatic enough, such an interview can probably be brought about. The story to be told in justification for State financial assistance is thoroughly sound, and if the alternative—heavy outlay in out-of-work donations with no compensating advantage and many disadvantages—is sufficiently stressed, there should be hope of convincing the Government that it would be sound policy to give financial assistance to compensate the mines for the damage caused them by national policy.

The Committee's recommendation on State aid is that the Government should take powers, analogous to those in force in the Dominions, to extend financial assistance, on the advice of the proposed Mines Department, to enable companies to tide over their difficulties or to undertake approved exploration and development; further that the funds at the disposal of the Development Commissioners under the Development and Road Improvement Funds Act 1909 should be made available for this purpose. While this is satisfactory so far as it goes, it will not meet the immediate needs of the case, and we fancy, too, that there will be considerable opposition to this course. The demands for assistance out of this fund for the improvement of the main roads, which were so neglected during the war, are heavy and insistent. Then, too, Colonial practice is to make loans for the purposes named, but the Cornish mines do not want loans secured by a first charge on the profits and assets of the companies; an absolute grant by way of reparation is what is wanted and justified.

The other principal recommendations of the Committee which concern tin-mining interests are: (1) that the various duties relating to the mining of minerals other than coal, now entrusted to a number of departments, should be centralized in one organization, which should undertake certain geological and statistical work. Under the Coal Mines Bill which is shortly to be laid before the House of Commons, it is believed that a new department with greatly extended powers is to be set up to more or less control the coal mines of this country, and doubtless an effort will be made to bring the metalliferous mines also within its orbit. We hope any such suggestion will be most strenuously opposed, because it is perfectly certain that any such department will be staffed principally by engineers and others who have only experience of coal mining and who have no knowledge of the real needs of the metalliferous miners, with the consequence that their interests will be swamped. As the Committee recommend, it would seem much more appropriate to expand the existing Mineral Resources Development branch of the Board of Trade.

(2) That it should be made compulsory on mine-owners to deposit with the Mines Department, and to bring up to date, both surface and underground plans of all mines. The idea is that it should be obligatory to prepare and keep two sets of plans, one of which is to be forwarded to the department and the other retained at the mines. Each six months the

two sets would be exchanged. This is a most valuable suggestion, particularly if anyone can have access to those kept by the department, and should be of great assistance to engineers engaged on exploratory work on contiguous areas. In the past, particularly in Cornwall, there has often been a reluctance on the part of some managers to show their plans to others, with the consequence that much money has been wasted on proving facts which had already been proved by others. It should also have the result of making all mine managers keep complete and accurate plans, which is by no means the case at present; we recall a quite recent case, at a fairly large mine in Cornwall, when, in response to an inquiry for information usually available on well-kept plans, the manager replied that he kept that information in his head!

(3) That any party desirous of obtaining a mineral lease, or of obtaining a modification of an existing lease, should, in the event of disagreement, have the right to refer to the Mines Department for their decision upon the matter at issue. The idea is that a Mines Tribunal, consisting of an independent chairman, assisted by two technical mining assessors, should be set up with power to decide, upon appeal, all questions relating to mineral leases, wayleaves, easements, barriers, encroachments, and the like which shall have been referred to the department. When the owner or lessee refuses to accept any recommendations of the department which they consider essential to prevent the loss of minerals to the nation, the department should have power to make a compulsory order, subject to appeal to the Tribunal referred to, whose decision would be final and binding. Anyone who has had much experience of mining in the West of England will appreciate the necessity of the Government granting such powers.

The Committee do not favour nationalizing mineral rights, on the ground that the prospective value of a metalliferous lode cannot be assessed even approximately; its very existence is only a matter of conjecture, and neither its extent nor its value can be ascertained until it has been developed. As regards royalties, the Committee think some revision of the existing system necessary, but they make no recommendation. We had hoped that they would see their way to urge a system of royalty based solely on profits.

The evidence of various witnesses is not included in the report, and to this extent the report is incomplete; we understand, however, that the Year Book for the current year of the Cornish Chamber of Mines will contain the main evidence of the principal witnesses representing West of England interests.

DOLCOATH.—Notice has been given to the 700 employees that operations will be suspended at this wonderful old mine on June 23, unless in the meantime the Government comes to the company's aid. The cause obviously is the recent heavy fall in the price of tin, which, coupled with the high cost of production, makes it impossible to operate the mine without loss. As the company's capital is exhausted, no alternative is now possible, but we regret that the directors had not the courage to suspend operating the old mine over a year ago. Had this been done, the money then in hand could have been spent on the proposed cross-cut in the direction of the Roskears, which is a most promising exploratory work, whereas, now, the money has been frittered away in losses. We sincerely hope that means will yet be found of averting what will be a most disastrous step to Camborne district.

GRENVILLE.—Notice of suspension has also been issued by the directors of this company, the new capital raised by the recent reconstruction being already nearly exhausted. It is most unfortunate that the new management has so soon been faced with a set of conditions, beyond their control, which necessitate the suspension of operations, for we believe that, given a fair chance, they would have brought Grenville once more to the forefront as a Cornish tin producer. We trust that here again something may occur at the last hour to avoid the necessity of closing down this famous mine.

TIN TICKETING.—This ancient comedy appears to be nearing its end. At the last auction, only Tincroft had the temerity to submit in all 10 tons for sale, and, to judge from the reports, the bidding was not too keen, as the margin between the offers was substantial. This in itself proves the unsatisfactoriness of this method of sale; clearly the seller is entitled to the full market value of his concentrate, based on its tin content, less a returning charge which shall show a reasonable rate of profit to the buyer. But at the Ticketing the smelters' bids depend largely on their individual requirements of a particular class of concentrate, and certainly the tin content is not the consideration, apart from smelting costs, which influences the bids. Few will shed tears over the demise of the Tin Ticketing, although it certainly was an improvement over the previous "pot-luck" private sale.

PERSONAL

H. A. BARKER has gone to Peru on investigation work for the Anglo-French Ticapampa Silver Mining Company.

DR. F. A. BATHER will preside over the geological section at the Cardiff meeting of the British Association.

H. C. BELLINGER, manager of the Chuquicamata copper mine, is visiting the United States.

HARRY BREARLEY was presented with the gold medal of the Iron & Steel Institute last month. He is well known in connection with the invention of rustless and stainless steel.

RAYMOND BROOKS passed through London on his way from the United States to the Congo State.

GEORGE CHALMERS, manager of the St. John del Rey Mining Co., has presented specimens of the South American rattlesnake to the Zoological Gardens, London.

L. MAURICE COCKERELL has returned from Mexico.

H. F. COLLINS is paying a short visit to Spain.

DR. F. G. COTTRELL, of electrostatic dust-precipitation fame, has been appointed director of the United States Bureau of Mines, in succession to VAN H. MANNING, who has accepted the position of director of research work for the American Petroleum Institute.

H. LIPSON HANCOCK has returned to the Wallaroo & Moonta Mines, on the conclusion of his visit to the United States.

R. W. HANNAM is here from Nigeria.

D. D. HENDERSON, of the firm of Inder, Henderson, & Dixon, has left for Colombia.

J. S. HENRY, of Melbourne, has been examining the Ronpibon alluvial tin properties in Malaya with a view to advising for a bucket-dredge.

DR. ARTHUR HOLMES has been appointed geological adviser to Yomah Oil Co., Ltd., and will proceed to Egypt, India, and Burma in September.

CHARLES E. JOBLING has left for Sweden.

T. J. JONES has returned from British Columbia and the United States, and has since left for France.

PAUL KESTNER has been awarded the medal of the Society of Chemical Industry.

E. KNIGHT, lately of Great Cobar, has been appointed chief engineer for the Laloki Copper Company, Papua.

J. G. LAWN has been appointed a member of the council of the South African School of Mines and Technology.

V. F. STANLEY LOW has concluded his visit to the Malay Peninsula and is returning to England by way of Australia.

W. A. MACLEOD has gone to Roumania.

RICHARD MARSH, Jr., is here from the United States.

H. D. MARTIN has returned from Asia Minor.

P. B. NYE has been appointed Assistant Government Geologist of Tasmania.

R. E. H. POMEROY has resigned as smelter superintendent for the Nevada Consolidated Copper Co., and has joined the Bonnot Company, of Canton, Ohio, as chief engineer of their pulverized-coal department.

CAPTAIN R. G. STICKLAND has left for Sarawak.

F. L. STILLWELL has been appointed geologist to the Bendigo Amalgamated Goldfields Company.

E. G. STONE is erecting reinforced concrete ore-bins at the Broken Hill South mine.

H. L. SULMAN gave two lectures early this month at the Sir John Cass Technical Institute on "Factors in the Froth-Flotation of Minerals."

DR. E. O. TEALE is expected in London from the Gold Coast.

C. M. WELD has returned to the United States from Brazil.

H. H. YUILL, of Bainbridge, Seymour & Co. Ltd., has gone to Canada.

The members of the "M. & M." Golfing Society held their spring meeting on the course of the Beaconsfield Golf Club, on May 18. The entries numbered 20, and the following eight qualified for the match play stages for the "Farrar" Challenge Cup: J. E. Lawler 88, W. T. Key 89, Sir John Craggs 90, C. V. Grundy 90, E. Hooper 91, O. J. Stannard 93, W. M. Richmond 94, W. G. Wagner 96.

A. H. HIORNS, for many years head of the metallurgical department of the Birmingham Municipal Technical School, died on April 17. He was well known as the author of a number of students' text-books, dealing with metallurgy, assaying, alloys, and metallography.

THE LATE JOHN S. MACARTHUR.—The following account of the late J. S. MacArthur, written by Bertram Hunt, appears in the *Journal* of the Society of Chemical Industry: "John Stewart MacArthur, the inventor of the cyanide process of gold extraction, died on March 16, in Pollokshields, Glasgow. Born in Glasgow sixty-three years ago, he entered the laboratory of the Tharsis Sulphur & Copper Co. in 1871 as an apprentice chemist. In 1881 his work in connection with the recovery of precious metals from the Tharsis copper liquors directed his attention to the extraction of gold from ores, and in 1885 he entered into partnership with the Drs. Forrest, who placed at his disposal a small room in their surgery for conducting his researches. In the same year the Cassel Gold Extracting Co. was formed to work the Cassel patents. About this time an article by MacArthur on the Cassel process was published in *Industries*, and arrested the attention of many interested in gold-extraction processes. The directors of the Cassel Company, unable to get results from their process, asked MacArthur's help, and in 1886 he joined the company as technical manager, when determined efforts were made by him to render the Cassel process operative. In the meantime, MacArthur and his partners had made the discovery that a weak solution of plain potassium cyanide dissolved the gold from ores, and this discovery was disclosed to the directors of the Cassel Co., at whose works the process was thoroughly tested. The results from the treatment of 15 tons of ore from the New Zealand Crown Mines proved the process a commercial proposition, and a contract was made with this company to erect a plant in New Zealand. South Africa was the next field exploited, and here the success of the process opened a new era for the Rand and a new chapter in the history of the world's gold production. From this beginning the cyanide process spread all over the world, and may be truly said to have created a new source of wealth. In 1911, MacArthur took up the manufacture of radium compounds in Runcorn, and afterwards moved his works to Balloch, on Loch Lomond side. During the war he produced radium for medicinal use and for making luminous paint for military purposes, the whole output being taken by the Government. In 1892 he became a member of the Institution of Mining and Metallurgy, and in 1902 was the recipient of the gold medal of the Institution in recognition of his work in the introduction and development of the cyanide process. He was an original member of the Society of Chemical Industry."

TRADE PARAGRAPHS

THE EDGAR ALLEN NEWS for May contains interesting articles on the heat-treatment of tool steels and on the Aero coal-pulverizer.

ALLDAYS & ONIONS, LTD., Great Western Works, Birmingham, send us illustrated pamphlets describing their oil-burners for use in steam-raising.

HUGH WOOD & CO., LTD., of Newcastle-on-Tyne, send us a pamphlet illustrating the "Huwood" hammer-drill. Type "L" weighs 22 lb., and type "H" 28 lb.

THE GENERAL ELECTRIC CO., LTD., 67, Queen Victoria Street, London, E.C.4, send us a revised edition of Section X of their catalogue relating to high-tension switchgear.

THE STURTEVANT ENGINEERING CO., LTD., 147, Queen Victoria Street, London, E.C.4, send us catalogue 1,072 describing their system of mechanical draught for boiler-furnaces.

VISLOK, LTD., 3, St. Bride's House, Salisbury Square, London, E.C.4, send us their pamphlets relating to the Vislok self-locking nut. As most mining engineers know, this nut will not shake loose when exposed to even the most violent vibration.

THE SVENSKA DIAMANTBERGBORRNINGS AKTIEBOLAGET, of Stockholm, announce that they have appointed the Wilfley Company, Ltd., of Salisbury House, London, E.C.2, as sole representatives for the British Empire and the Colonies, with the exception of India and Burma.

GEORGE CRADOCK & CO., LTD., Wakefield, have issued a folder describing their "Silverlock" locked-coil steel rope. The constituent wires are heavily coated with metal before the rope is spun, the object of this covering being to prevent corrosion. We hope to give further details of this important improvement in an early issue.

ROPEWAYS, LTD., of Eldon House, London, E.C.2., have recently built an aerial ropeway in Colombia, connecting Mariquita on the Dorada railway in the Magdalena valley, with Manizales. This ropeway is 74 kilometres long and, in passing over a spur of the Andes, rises to a height of over 12,000 ft. above sea-level. The altitude of Dorada is 15,000 ft. and that of Manizales 6,700 ft. Full particulars of this notable installation are given in *The Engineer* for May 14.

VICKERS, LTD., have issued particulars of the "Narragansett," a vessel recently completed at their shipbuilding yards at Barrow-in-Furness. This ship is an oil tanker, and is driven by internal-combustion engines using heavy crude oil. It has been built for the Anglo-American Oil Co., Ltd. The dimensions are: Length between perpendiculars, 435 ft.; breadth moulded, 56 ft. 8 in.; total dead-weight capacity, 10,050 tons; bunker capacity (oil), 733 tons; draught, 26 ft.; cargo capacity, 9,420 tons of oil. The company has on the stocks or on order a number of other oil tankers to be driven by engines of the same class.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO., of Pittsburgh, Pennsylvania, send us an account of the performance of an electrically-driven shovel used in excavating the Queenstown-Chippawa power canal for the Hydro-Electric Power Commission of Canada. Over 20,000 cu. yd. of earth and rock are removed daily in digging this canal, the greater portion of this being done by three 8 cu. yd. electrically-driven shovels. Not only have the volume records indicated the success of these shovels, which are believed to be the largest in the world, but the operating economies have also proved the value of this equipment. The operating economies were found by making a test on shovel No. 1. This Bucyrus shovel is of 300 ton weight, has a 90 ft. boom, uses either 5, 6, or 8 cu. yd. buckets, and is operated by a current on a 40 to 50 second cycle. There are four Westinghouse 440-volt, 3-phase, 25-cycle motors on this shovel, used as follows: two 250 h.p. for hoist, one 150 h.p. for thrust, and one 150 h.p. for swing. The controllers are of the master-switch magnetic type, and the whole operation is handled by two men. This shovel was working 90 ft. below the surface and loading material on cars approximately 70 ft. above their own base. An interesting feature of the operation of these shovels is the fact that regenerative braking is utilized whenever possible. In this particular instance it is used when the shovel is lowered the 40 ft., after it has been raised that distance in order to load the cars. This is accomplished as follows: When the operator is ready for the bucket to come down, the motors are connected to the power-supply, and the bucket falls with the motors running at slightly above synchronous speed. When such a condition is reached, the motors operate as induction generators. This method of lowering saves mechanical wear and tear, as the brakes are required only for stopping and holding the bucket, requiring less repair work and making the whole equipment more reliable.

METAL MARKETS

COPPER.—There is not much change in the general situation of this metal so far as the United States is concerned during the past month. The business moving in that quarter with domestic consumers has, of course, been somewhat retarded by the railway trouble there. Were it not for this, the consumption would no doubt be very good in that country, but even granting that this is so, it seems rather doubtful whether the demand is sufficiently large to satisfy producers without the assistance of an export movement of importance. As a consequence prices tended rather easier, and it was reported that cut quotations had been made to Continental buyers. Some fairly large business is reported to have been done with France on the new credit terms. When this scheme gets into fuller operation, and credits are extended to Belgium and Italy as well, as it is understood it is proposed to do, the amount of shipment business may materially increase. Of course, a serious factor in the position in Europe is the amount of scrap metal of various kinds which is available, and indeed the quantities coming on the market seem rather inclined to increase than to diminish. This naturally has a serious effect on the amount of new copper which is required from America, and it remains doubtful whether producers will be able to maintain their present ideas of price. Meanwhile in this country prices declined. This was brought about by some free selling of standard. It was somewhat difficult to arrive at the precise reason of this selling, but it may quite probably have been a result of the declines in other markets. At all events prices of standard were reduced considerably, and values of refined metal were affected sympathetically. Business with the consuming trades in this country in virgin copper has not been particularly brisk, such trade having been retarded as already indicated by the quantities of scrap metal available at relatively cheap prices. Business with the Continent seems to be gradually opening up, and, although it does not amount to anything important, yet this should be facilitated by the improving rates of exchange. Inquiry for manufactured copper for home purposes has been pretty good, but from India has lessened considerably.

DAILY LONDON METAL PRICES: OFFICIAL CLOSING
Copper, Lead, Zinc, and Tin per Long

COPPER

	Standard Cash	Standard (3 mos.)	Electrolytic Ingots	Electrolytic Wire-Bars	Best Selected
May	£ s. d. £ s. d.	£ s. d. £ s. d	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
11	101 5 0 to 101 10 0	103 15 0 to 104 0 0	112 0 0 to 114 0 0	112 0 0 to 114 0 0	111 0 0 to 112 0 0
12	101 5 0 to 101 10 0	103 15 0 to 104 0 0	112 0 0 to 114 0 0	112 0 0 to 114 0 0	111 0 0 to 112 0 0
13	100 15 0 to 101 0 0	103 5 0 to 103 10 0	112 0 0 to 114 0 0	112 0 0 to 114 0 0	111 0 0 to 112 0 0
14	100 15 0 to 101 0 0	103 0 0 to 103 5 0	112 0 0 to 114 0 0	112 0 0 to 114 0 0	111 0 0 to 112 0 0
17	99 5 0 to 99 10 0	102 0 0 to 102 5 0	112 0 0 to 114 0 0	112 0 0 to 114 0 0	111 0 0 to 112 0 0
18	98 5 0 to 98 10 0	101 0 0 to 101 5 0	110 0 0 to 112 0 0	110 0 0 to 112 0 0	110 0 0 to 111 0 0
19	87 10 0 to 88 0 0	92 0 0 to 92 10 0	106 0 0 to 108 0 0	106 0 0 to 108 0 0	110 0 0 to 111 0 0
20	90 0 0 to 90 10 0	94 10 0 to 95 0 0	107 0 0 to 109 0 0	107 0 0 to 109 0 0	110 0 0 to 111 0 0
21	90 5 0 to 90 10 0	94 10 0 to 95 0 0	107 0 0 to 109 0 0	107 0 0 to 109 0 0	106 0 0 to 107 0 0
25	88 0 0 to 88 10 0	92 5 0 to 92 10 0	107 0 0 to 109 0 0	107 0 0 to 109 0 0	106 0 0 to 107 0 0
26	89 10 0 to 90 0 0	93 10 0 to 93 15 0	105 0 0 to 107 0 0	105 0 0 to 107 0 0	106 0 0 to 107 0 0
27	91 15 0 to 92 0 0	95 10 0 to 95 15 0	105 0 0 to 107 0 0	105 0 0 to 107 0 0	106 0 0 to 107 0 0
28	93 10 0 to 94 0 0	96 10 0 to 97 0 0	105 0 0 to 107 0 0	105 0 0 to 107 0 0	104 0 0 to 105 0 0
31	95 0 0 to 95 5 0	98 10 0 to 99 0 0	105 0 0 to 107 0 0	105 0 0 to 107 0 0	104 0 0 to 105 0 0
June					
1	96 5 0 to 96 10 0	98 10 0 to 98 15 0	106 0 0 to 109 0 0	107 0 0 to 109 0 0	105 0 0 to 106 0 0
2	95 0 0 to 95 5 0	98 0 0 to 98 5 0	106 0 0 to 110 0 0	108 0 0 to 110 0 0	105 0 0 to 106 0 0
3	92 10 0 to 92 15 0	95 5 0 to 95 10 0	106 0 0 to 110 0 0	108 0 0 to 110 0 0	105 0 0 to 106 0 0
4	91 2 6 to 91 7 6	94 0 0 to 94 5 0	106 0 0 to 110 0 0	108 0 0 to 110 0 0	105 0 0 to 106 0 0
7	90 15 0 to 91 0 0	94 0 0 to 94 5 0	106 0 0 to 110 0 0	108 0 0 to 110 0 0	105 0 0 to 106 0 0
8	91 0 0 to 91 5 0	94 0 0 to 94 5 0	106 0 0 to 110 0 0	108 0 0 to 110 0 0	105 0 0 to 106 0 0
9	90 0 0 to 90 5 0	93 10 0 to 93 15 0	106 0 0 to 110 0 0	108 0 0 to 110 0 0	105 0 0 to 106 0 0

Average price of cash standard copper: May 1920, £96. 18s. 1d; April 1920, £103. 2s. 11d.; May 1919, £77. 16s. 8d.; April 1919, £77. 7s.

TIN.—The downward tendency in this market, which had already commenced, was continued to a most marked degree during the month of May, so that the fall amounted at one time to something like £150 per ton since the latter part of February. The reason of the decline was, of course, in the first place the free selling which was witnessed in the standard market by interests usually associated with dealings in Dutch tin, and this was followed, as mentioned in our last report, by the arrival of some 2,000 tons of Banka tin from Holland. It had apparently been hoped that a large portion of the sales made in the standard market would have to be covered in again on that market, but the arrival of the metal referred to defeated such hopes, and the consequent liquidation of bull commitments had a demoralizing effect, with the result that prices dropped rapidly. At around £300 per ton some support was in evidence, but this was subsequently withdrawn, with the result that weakness continued. From time to time America stepped in, and did some business here, but this was not sufficient to stay the decline. Meanwhile home consumers have confined their purchases to necessities in view of the rapidly receding prices. The fact of the matter is that there was much over-speculation for the rise, and prices were driven to far too high levels, and the decline has been the readjustment of values to more natural levels, the process being assisted by the difficulty of financing holdings. The recent financial unsettlement in Japan and the fall in the value of silver have also been instrumental in bringing out some of the holdings of tin in China, all of which factors contributed to the decline.

Average price of cash standard tin: May 1920, £295. 3s. 7d.; April 1920, £345. 13s. 1d.; May 1919, £234. 9s. 5d.; April 1919, £225. 6s. 6d.

LEAD.—This market has been somewhat unsettled during the past month, and quotations have shown a fluctuating tendency. There has been, so far, no setlement of the strike trouble at Broken Hill, which has now continued for 12 months. It is still hoped that some basis of agreement will be arrived at, thus enabling a resumption of work before long. Of course, even assuming that the best happens, it must still be a long time before the new production can arrive in this country. Meanwhile fair shipments continue to come to hand from stock in Australia, and this, combined with the lead already in this country, prevents there being any scarcity of the metal. Opinion is divided as to whether existing supplies can suffice until the new production is available. Meanwhile the demand both for home trade and export is rather restricted, and it can at least be said that the supplies in sight should be sufficient for a good long while. The market has, of course, at times been depressed to a certain extent by outside influences, such as financial conditions and the weakness in other metals. The market in the United States has been somewhat dull, and the chief producers there reduced their price from 9·25 cents to 8·50 cents. It has been reported from time to time that America was proposing to buy here, but it seems doubtful if much, if any, business has been actually effected. A feature has been the arrival and offering of Spanish metal here, the great bulk of that country's production having until recently gone to France. Operations of the Penarroya Company were interfered with by a strike which it is understood is now settled, however.

Average price of soft pig lead: May 1920, £39. 3s. 2d.; April 1920, £40. 4s.; May 1919, £23. 18s. 6d.; April 1919, £24. 8s. 7d.

SPELTER.—This market has not moved to a very wide extent during the month, but the general tendency has been toward lower values. Business with the consuming trades has been quiet, partly owing to difficulties of transport, the canal bargemen's strike in the Midlands having considerably hampered operations of works. As a consequence there was little important demand to reflect itself in the Metal Exchange, where the realization of speculative parcels had a depressing influence on prices. Meanwhile in America prices have ruled above the parity of values here, but the tendency there seems to be easier. There seems no doubt that more spelter is being turned out there than can be absorbed by the domestic trade, and in the absence of demand from this side the market could not be expected to bear a very strong appearance. It now remains to be seen whether sellers there will reduce prices to the parity of values here, or whether the market here will

PRICES ON THE LONDON METAL EXCHANGE

Tons; Silver per Standard Ounce; Gold per Fine Ounce.

Lead: Soft Foreign	Lead: English	Zinc (Spelter)	Standard Tin: Cash	Standard Tin: 3 mos.	Silver: Cash	Silver (forward)	Gold	Date
£ s. d. £ s. d.	£ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	d.	d.	s. d.	May
38 0 0 to 39 5 0	40 0 0	45 15 0 to 47 [illegible]	[illegible] to 300 0 0	301 10 0 [illegible] 0 0	[illegible]	[illegible]	[illegible]	[illegible]
37 5 0 to 38 10 0	40 0 0	45 10 0 to 47 [illegible] 0	299 0 0 to 300 0 0	301 0 0 to 302 [illegible]	[illegible]	[illegible]	[illegible] 6	[illegible]
37 5 0 to 39 5 0	40 0 0	45 10 0 to 47 [illegible] 0	297 0 0 to 297 10 0	300 0 0 to 300 [illegible]	[illegible]	[illegible]	[illegible] 6	[illegible]
38 10 0 to 40 0 0	41 0 0	45 15 0 to 47 5 0	296 10 0 to 297 10 0	301 0 0 to 302 [illegible]	[illegible]	[illegible]	[illegible] 0	[illegible]
40 5 0 to 41 15 0	43 0 0	45 15 0 to 47 10 0	295 15 0 to 296 [illegible]	300 0 0 [illegible]	[illegible]	[illegible]	[illegible] 1	[illegible]
40 0 0 to 41 10 0	43 0 0	45 0 0 to 46 10 0	287 0 0 to 288 0 0	291 0 0 to 292 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
37 5 0 to 38 10 0	40 0 0	44 15 0 to 46 5 0	283 0 0 to 284 0 0	287 0 0 to 288 [illegible]	[illegible]	[illegible]	108	[illegible]
37 15 0 to 39 0 0	40 5 0	43 15 0 to 45 15 0	277 10 0 to 278 10 0	282 10 0 [illegible]	[illegible]	[illegible]	108 0	20
38 10 0 to 39 15 0	41 0 0	43 15 0 to 45 15 0	275 0 0 to 276 0 0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
39 0 0 to 40 10 0	41 10 0	44 0 0 to 46 5 0	269 0 0 to 270 0 0	275 0 0 to 275 10 0	[illegible]	[illegible]	107	[illegible]
38 15 0 to 40 0 0	41 10 0	43 10 0 to 45 15 0	262 0 0 to 263 0 0	269 0 0 to 270 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
38 10 0 to 39 15 0	41 0 0	43 5 0 to 45 10 0	270 10 0 to 271 0 0	277 10 0 to 278 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
38 10 0 to 39 10 0	41 0 0	43 15 0 to 46 0 0	274 10 0 to [illegible] 0	280 10 0 to [illegible] 0 [illegible]	[illegible]	[illegible]	[illegible] 6	28
39 0 0 to 40 0 0	41 10 0	44 0 0 to 46 5 0	274 10 0 to 275 0 0	280 0 0 to 280 10 [illegible]	[illegible]	[illegible]	106	[illegible]
								June
39 0 0 to 40 0 0	41 10 0	44 5 0 to 46 10 0	272 10 0 to 273 0 0	279 10 0 to 280 0 [illegible]	[illegible]	[illegible]	[illegible]	1
38 0 0 to 39 5 0	40 10 0	43 10 0 to 45 15 0	273 15 0 to 274 5 0	280 10 0 to 281 0 [illegible]	57	[illegible]	104 10	2
37 0 0 to 38 0 0	39 10 0	41 15 0 to 43 15 0	263 10 0 to 264 10 0	271 0 0 to 272 0 0	[illegible]	[illegible]	[illegible] 0	[illegible]
37 0 0 to 38 0 0	39 10 0	42 10 0 to 44 10 0	255 0 0 to 256 0 0	261 0 0 to 262 0 0	56⅞	[illegible]	[illegible]	[illegible]
35 10 0 to 37 10 0	38 0 0	43 0 0 to 45 0 0	253 0 0 to 254 0 0	259 0 0 to 260 0 [illegible]	[illegible]	54⅛	[illegible]	7
36 10 0 to 38 5 0	39 0 0	43 10 0 to 45 10 0	255 10 0 to 256 0 0	262 10 0 to 263 [illegible]	[illegible]	[illegible]	105 [illegible]	8
36 5 0 to 38 0 0	39 0 0	42 15 0 to 44 15 0	253 0 0 to 254 0 0	259 10 0 to 260 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]

need to conform to those in America. In view of the amount of spelter already bought by this country, and the lack of important consuming demand, coupled with the possibilities of increased supplies from the Continent, it looks more like as if the American market will require to come down toward our level. Some sales have been made recently by Belgium to this country, and it is reported that production in Germany is now over 50% of pre-war output. Meanwhile the export of the metal from that country has been prohibited, but it is now reported that the embargo has been removed to the extent of 25% of the production.

Average price of spelter: May 1920, £46. 0s. 9d.; April 1920, £48. 9s. 4d.; May 1919, £35. 13s. 9d.; April 1919, £35. 18s. 3d.

ZINC DUST.—The price of Australian high-grade material remains at £85 per ton.

ANTIMONY.—The price of English regulus was reduced to £65 per ton in May, while a further decline occurred early in June, bringing the price to £60. Foreign regulus is also easy and could be had at £49 per ton c.i.f.

ARSENIC.—There is very little demand, but the price is steady at £68 to £70 for white delivered London.

BISMUTH.—A fairly good business is being done at 12s. 6d. per lb.

CADMIUM.—A fair inquiry is about, and a moderate business is passing at 6s. 6d. to 6s. 9d. per lb.

ALUMINIUM.—Steady and unchanged at £165 for home consumption and £185 for shipment.

NICKEL.—The demand is fairly good; the price remains at £230 for home and export.

COBALT METAL.—14s. per lb.

COBALT OXIDE.—10s. per lb. (black).

PLATINUM.—Supplies are plentiful and the market is dull owing to lack of demand. The quotation is nominally £20 to £22 per oz.

PALLADIUM.—Nominal and unquoted.

QUICKSILVER.—The market has been weak owing to the presence of second-hand parcels and offers to resell by Eastern markets. Prices fell to about £17. 10s. per bottle, but early in June the market firmed up to about £21 to £21. 10s. per bottle.

SELENIUM.—10s. to 11s. per lb.

TELLURIUM.—95s. to 100s. per lb.

SULPHATE OF COPPER.—Very quiet at £44 to £45 per ton for prompt, but £50 is asked for forward delivery.

MANGANESE ORES.—Conditions have shown little alteration, but prices are very firm at 4s. to 4s. 6d. per unit c.i.f. U.K. for Indian grades. A parcel of Caucasian ore has recently reached this side, but further arrivals are uncertain at the moment.

TUNGSTEN ORES.—Business in wolframite is quieter, and the tendency easier, the price of 65% being about 30s. per unit, while 65% scheelite is quoted at about the same figure.

MOLYBDENITE.—Dull and prices nominal.

SILVER.—The market continues to decline, chiefly owing to less buying by Eastern markets. On May 1 the price of spot standard bars was 63⅞d. Values subsequently fell, touching 58d. on May 15. The tone then became a little firmer on renewed interest being taken in the article by China, but at the end of the month the quotation was 57⅝d., and early in June a spectacular fall was recorded.

GRAPHITE.—Quiet and unchanged, quotations ranging from £60 to £80 for soft velvety flake 85% to to 90%, to £19 to £22. 10s. c.i.f. for Madagascar 82% to 85%.

CHROME ORES.—48 to 50%, £9 to £9. 10s. per ton.

IRON AND STEEL.—Following upon the rise in the price of industrial fuel the Cleveland iron-masters advanced their prices by 17s. 6d., making the quotations n force during May 230s. for No. 1 Cleveland, and 217s. 6d. for No. 3 G.M.B. and all inferior qualities, for the home trade, with an additional 5s. per ton for export to France, Belgium, and Italy. It was also decided that owing to the urgency of the home demand export business would be confined to the three countries named. As foreign ore freights were declining, thus off-setting the rise in fuel, it was not found necessary to advance the price of hematite, and East Coast mixed numbers are still quoted at 260s. for the home trade and 265s. for France, Belgium, and Italy. The demand for all grades of pig iron remains heavy. The prices of manufactured iron and steel naturally also tended upward owing to the rise in costs of raw materials. Makers are still very fully booked and it is difficult to place orders.

STATISTICS.

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand	Elsewhere	Total	Par Value
	Oz.	Oz.	Oz.	£
March, 1919	694,825	17,554	712,379	3,025,992
April	676,702	18,242	694,944	2,951,936
May	706,158	18,837	724,995	3,079,583
June	682,603	19,776	702,379	2,983,515
July	705,523	19,974	725,497	3,081,713
August	686,717	19,952	706,669	3,001,739
September	680,359	18,199	698,558	2,967,287
October	705,313	18,409	723,722	3,074,174
November	657,845	20,125	677,920	2,879,834
December	631,833	18,358	650,191	2,761,836
Year 1919	8,111,271	218,820	8,330,091	35,383,974
January 1920	653,295	17,208	670,503	*
February	607,918	17,412	625,330	*
March	689,645	17,391	707,036	*
April	667,926	19,053	686,979	*

* Not given in the official returns.

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold mines	Coal mines	Diamond mines	Total
March 31, 1919	175,620	11,168	5,080	191,868
April 30	175,267	11,906	5,742	192,915
May 31	173,376	12,232	5,939	191,547
June 30	172,505	12,544	5,831	190,880
July 31	173,613	12,453	5,736	191,802
August 31	170,844	12,450	5,655	188,949
September 30	169,120	12,392	5,294	186,806
October 31	167,499	12,691	4,492	184,682
November 30	164,671	12,565	4,337	181,573
December 31	166,155	12,750	4,271	183,176
January 31, 1920	176,390	12,766	4,796	193,952
February 29	185,185	12,708	5,217	203,110
March 31	188,564	12,788	5,232	206,584
April 30	189,446	12,951	5,057	207,454

COST AND PROFIT ON THE RAND.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 65% of the working profit. Figures for yield and profit for 1919 based on par value of gold; subsequently gold premium included.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d	s. d.	s. d.	£
March, 1919	2,082,469	28 2	22 6	5 6	573,582
April	1,993,652	28 7	22 9	5 9	573,143
May	2,099,450	28 4	22 3	5 10	608,715
June	2,032,169	28 4	22 4	5 10	592,361
July	2,134,668	27 10	21 9	6 0	611,118
August	2,036,128	28 5	22 11	5 5	551,203
September	2,019,109	28 6	22 10	5 7	560,979
October	2,108,698	28 3	22 6	5 10	612,841
November	1,933,526	28 8	23 5	5 5	521,472
December	1,845,088	28 8	25 6	3 10	354,098
Year 1919	24,043,638	28 7	22 11	5 6	6,605,509
January, 1920	2,038,092	34 4	24 2	10 2	1,036,859
February	1,869,180	35 1	28 3*	6 10*	644,571*
March	2,188,104	31 8	25 2	6 6	716,610

* Results affected by the back-pay disbursed in accordance with new wages agreement.

PRODUCTION OF GOLD IN RHODESIA AND WEST AFRICA.

	Rhodesia.		West Africa.	
	1919	1920	1918	1919
	£	oz.	£	£
January	211,917	43,428	107,863	104,063
February	220,885	44,237	112,865	112,616
March	225,808	45,779	112,605	112,543
April	213,160	47,000	117,520	109,570
May	218,057	—	126,290	100,827
June	214,215	—	120,273	106,612
July	214,919	—	117,581	102,467
August	207,339	—	120,526	103,112
September	223,719	—	115,152	100,401
October	204,154	—	61,461	91,352
November	186,462	—	108,796	98,322
December	158,835	—	112,621	98,806
Total	2,499,498	180,444	1,333,553	1,240,691

TRANSVAAL GOLD OUTPUTS.

	March.		April.	
	Treated	Yield	Treated	Yield
	Tons	Oz.	Tons	Oz.
Aurora West	14,000	£15,346	12,800	£14,796
Brakpan	52,500	£89,583	38,500	£74,146
City & Suburban	13,784	3,144	—	—
City Deep	62,500	25,317	60,000	25,012
Cons. Langlaagte	46,500	£64,729	43,700	£66,649
Cons. Main Reef	48,400	17,033	47,200	16,870
Crown Mines	202,000	59,290	182,000	54,879
Durban Roodepoort Deep	24,800	7,779	20,000	6,362
East Rand P.M.	124,000	33,389	128,000	34,196
Ferreira Deep	36,000	11,493	32,900	11,224
Geduld	45,000	15,990	42,000	14,909
Geldenhuis Deep	44,900	13,060	44,400	12,856
Glynn's Lydenburg	3,465	£5,899	3,555	£6,937
Goch	19,700	£16,383	18,800	£16,024
Government G.M. Areas	129,500	£270,483	125,000	£251,468
Heriot	11,800	3,054	10,700	2,791
Jupiter	25,800	5,911	23,000	10,392
Kleinfontein	48,260	14,100	50,440	14,297
Knights Central	26,250	7,819	24,400	7,623
Knights Deep	9,600	16,194	85,900	16,526
Langlaagte Estate	42,000	£59,240	39,000	£60,142
Luipaard's Vlei	21,230	£24,332	20,110	£25,929
Meyer & Charlton	13,030	£40,336	13,000	£40,284
Modderfontein	96,000	46,206	86,000	44,562
Modderfontein B	52,500	23,396	50,000	23,393
Modderfontein Deep	43,900	23,512	41,100	21,758
New Unified	11,000	£15,203	10,600	£14,828
Nourse	43,800	15,106	38,500	13,534
Primrose	19,000	£19,410	19,100	£20,200
Princess Estate	20,400	5,372	19,200	4,909
Randfontein Central	150,000	£213,737	130,000	£163,475
Robinson	41,600	9,191	40,100	9,520
Robinson Deep	55,200	17,207	51,200	18,180
Roodepoort United	22,200	£23,995	20,800	£21,285
Rose Deep	58,600	14,680	55,800	14,981
Simmer & Jack	47,000	10,941	55,500	12,359
Simmer Deep	43,700	9,515	47,400	10,392
Springs	41,000	£74,687	39,600	£76,916
Sub Nigel	10,300	6,058	10,100	5,705
Transvaal G.M. Estates	16,650	£30,992	16,760	£27,399
Van Ryn	37,450	£41,687	38,000	£43,471
Van Ryn Deep	53,000	£149,019	46,100	£127,183
Village Deep	47,800	13,823	46,300	14,393
Village Main Reef	18,400	5,106	16,400	4,833
West Rand Consolidated	32,300	£43,874	33,300	£43,342
Witwatersrand (Knights)	39,500	£54,446	37,250	£51,168
Witwatersrand Deep	34,300	10,971	34,200	8,926
Wolhuter	31,700	8,880	39,000	8,668

WEST AFRICAN GOLD OUTPUTS.

	March.		April.	
	Treated	Value	Treated	Value
	Tons	Oz.	Tons	Oz.
Abbontiakoon	7,736	£15,020	8,070	£16,243
Abosso	7,200	2,881	6,880	2,355
Akoko	300	290	—	—
Ashanti Goldfields	1,864	2,004	5,101	5,227
Obbuassi	496	419	542	543
Prestea Block A	11,200	5,876	9,676	£17,115
Taquah	4,750	2,882	4,700	2,813

RHODESIAN GOLD OUTPUTS.

	March.		April.	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Falcon	15,997	28,224*	14,376	25,580*
Gaika	3,460	5,301	3,403	5,536
Globe & Phœnix	5,966	6,462†	5,734	8,890†
London & Rhodesian	1,958	2,225	2,650	2,758
Lonely Reef	4,580	5,876†	4,850	5,422†
Rezende	5,800	2,510†	5,500	2,324†
Rhodesia, Ltd.	—	—	628	387
Rhodesia, G.M. & I.	574	387†	—	-
Shamva	51,301	39,909	53,288	41,576
Transvaal & Rhodesian	1,700	4,290	1,600	3,750

* Gold, Silver and Copper ; † Ounces Gold

WEST AUSTRALIAN GOLD STATISTICS.—Par Values.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
April, 1919	33	63,465	63,498	269,720
May	525	68,655	69,180	293,856
June	1,050	73,546	74,596	316,862
July	680	68,028	68,708	292,852
August	835	58,117	58,952	250,410
September	†	†	†	†
October	586	64,987	65,573	278,535
November	1,171	[illegible]	65,994	280,323
December	831	27,334	28,165	162,575
January, 1920	836	25,670	26,506	112,590
February	1,928	[illegible]	51,381	218,251
March	*nil*	54,020	54,020	229,461
April	835	56,256	57,091	242,506
May	227	50,976	51,203	217,495

† Figures not received.

AUSTRALIAN GOLD RETURNS.

	VICTORIA.		QUEENSLAND.		NEW SOUTH WALES	
	1919	1920	1919	1920	1919	1920
	£	Oz.	£	Oz.	£	£
January	36,238	7,105	37,100	4,724	18,000	28,000
February	46,955	—	43,330	7,200	24,000	15,000
March	40,267	—	48,000	7,000	16,000	22,000
April	63,818	—	61,200	8,400	24,000	12,000
May	37,456	—	38,200	—	16,000	13,930
June	41,465	—	44,600	—	17,000	—
July	37,395	—	42,060	—	22,000	—
August	51,564	—	49,700	—	20,000	—
September	76,340	—	37,120	—	13,000	—
October	39,018	—	36,100	—	28,000	—
November	40,735	—	32,720	—	51,000	—
December	63,311	—	44,500	—	31,000	—
Total	575,260	7,105	514,630	27,324	280,000	90,930

AUSTRALASIAN GOLD OUTPUTS.

	March.		April.	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
Associated	5,896	7,773	5,201	7,687
Blackwater	2,550	4,309	2,248	3,717
Bullfinch	6,000	5,096	3,110	4,484
Golden Horseshoe	11,196	20,023	11,808	23,444
Great Boulder Prop.	10,928	31,663	9,181	26,553
Ivanhoe	15,169	5,400‖	13,081	4,726‡
Kalgurli	3,920	7,983	2,963	4,735
Lake View & Star	8,873	10,982	8,704	10,473
Menzies Consolidated	1,710	3,527	1,440	2,954
Oroya Links	1,902	9,822‖	1,595	8,700‖
Progress	1,270	1,352	1,060	1,245
Sons of Gwalia	10,997	14,501	6,726	8,747
South Kalgurli	8,082	8,069	7,014	6,352
Waihi	13,742	4,278‡	4,547	[illegible]
Waihi Grand Junction	2,880	1,144‡	8,400A	2,526‡

† Total receipts ; ‡ Oz. ; ‖ Profit ; A Six weeks.

MISCELLANEOUS GOLD OUTPUTS.—Par Values.

	March.		April.	
	Treated	Value	Treated	Value
	Tons	£	Tons	£
El Oro (Mexico)	31,000	238,000†	29,750	213,000†
Esperanza (Mexico)	19,541	1,772§	23,022	560§
Frontino & Bolivia (C'lbia)	2,410	9,031	2,250	8,813
Mexico El Oro (Mexico)	11,770	219,000†	11,208	180,370†
Oriental Cons. (Korea)	—	116,000†	—	101,610†
Ouro Preto (Brazil)	7,900	2,726	7,400	[illegible]
Plymouth Cons. (Calif'rnia)	8,600	11,681	7,600	10,845
St. John del Rey (Brazil)	—	36,900	—	33,000
Santa Gertrudis (Mexico)	31,360	37,640‡	27,260	30,205‡

§ Loss. † Dollars. ‡ Profit, gold and silver. ‖ Oz.

[illegible]

	[illegible]	1917	[illegible]	[illegible]	[illegible]
	[illegible]	oz.	[illegible]	[illegible]	[illegible]
January	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
February	[illegible]	42,566	40,787	[illegible]	[illegible]
March	[illegible]	44,617	41,719	[illegible]	[illegible]
April	44,797	[illegible]	41,504	[illegible]	[illegible]
May	45,055	[illegible]	[illegible]	[illegible]	[illegible]
June	[illegible]	42,924	[illegible]	[illegible]	—
July	[illegible]	[illegible]	[illegible]	[illegible]	—
August	[illegible]	42,591	[illegible]	[illegible]	—
September	[illegible]	43,207	[illegible]	[illegible]	—
October	45,061	43,041	39,472	[illegible]	—
November	[illegible]	42,915	[illegible]	[illegible]	—
December	48,276	[illegible]	[illegible]	[illegible]	—
Total	541,077	520,362	485,236	[illegible]	[illegible]

[illegible]

	April.		May	
	Tons Treated	[illegible]	[illegible]	[illegible]
Balaghat	[illegible]	[illegible]	3,600	[illegible]
Champion Reef	12,223	6,938	[illegible]	[illegible]
Mysore	20,168	[illegible]	[illegible]	[illegible]
North Anantapur	700	1,076	700	1,796
Nundydroog	8,527	[illegible]	8,258	[illegible]
Ooregum	12,550	[illegible]	12,800	7,628

BASE METAL OUTPUTS.

		March.	April.
Arizona Copper	Short tons copper	1,500	1,500
British Broken Hill	Tons lead conc.	—	—
	Tons zinc conc.	—	—
	Tons carbonate ore	—	—
Broken Hill Block 10	Tons lead conc.	—	—
	Tons zinc conc.	—	—
Burma Corp.	Tons refined lead	2,181	[illegible]
	Oz. refined silver	[illegible]	233,800
Fremantle Trading	Long tons lead		—
Hampden Cloncurry	Tons copper	156	—
North Broken Hill	Tons lead	—	—
	Oz. silver	—	—
Poderosa	Tons copper ore	—	430
Rhodesian Broken Hill	Tons lead	1,002	1,286
Tanganyika	Long tons copper	[illegible]	1,180
Tolima	Tons silver-lead conc.	35	[illegible]
Zinc Corp.	Tons zinc conc.	—	—
	Tons lead conc.	—	—

IMPORTS OF ORES, METALS, ETC., INTO UNITED KINGDOM.

		April	May.
Iron Ore	Tons	748,418	710,592
Manganese Ore	Tons	25,120	30,899
Copper and Iron Pyrites	Tons	64,593	68,112
Copper Ore, Matte, and Precipitate	Tons	659	2,185
Copper Metal	Tons	10,263	8,152
Tin Concentrate	Tons	4,243	3,485
Tin Metal	Tons	1,440	4,763
Lead, Pig and Sheet	Tons	10,436	14,568
Zinc (Spelter)	Tons	10,537	11,905
Quicksilver	Lb.	45,855	374,677
Zinc Oxide	Tons	[illegible]	[illegible]
White Lead	Cwt.	22,277	26,975
Barytes	Cwt.	48,553	[illegible]
Phosphate	Tons	66,976	[illegible]
Sulphur	Tons	564	6,105
Borax	Cwt.	2,000	—
Other Boron Compounds	Tons	1,978	2,598
Nitrate of Soda	Cwt.	164,980	101,785
Nitrate of Potash	Cwt.	23,595	15,524
Petroleum:			
Crude	Gallons	546,971	43,945
Lamp Oils	Gallons	12,883,600	13,369,666
Motor Spirit	Gallons	10,397,779	16,127,343
Lubricating Oils	Gallons	13,156,233	10,214,742
Gas Oil	Gallons	7,168,314	4,530,795
Fuel Oil	Gallons	33,850,764	24,626,289
Total Petroleum	Gallons	78,022,761	68,941,603

United States Metal Exports and Imports.

Exports.	Oct. Tons.	Nov. Tons.	Imports.	Oct. Tons.	Nov. Tons.
Copper Ingots	19,643	12,802	Antimony	1,083	251
Copper Tubes	350	197	Tin Con.	2,366	1,172
Copper Sheets	311	203	Tin	7,237	6,800
Copper Wire	1,835	1,464	Manganese Ore	15,863	11,694
Lead, Pig	3,721	2,511	TungstenCon	592	1,423
Zinc	9,650	5,009	Pyrites	67,155	40,259
Zinc Sheets	1,231	1,063			

Outputs of Tin Mining Companies.
In Tons of Concentrate.

	Feb. Tons	March Tons	April Tons
Nigeria:			
Associated Nigerian	–	20	20
Benue	4	4¼	4
Bisichi	7	12	12
Bongwelli	4½	–	–
Dua	4⅛	3¼	1¾
Ex-Lands	30	30	20
Filani	3¼	3½	5¼
Forum River	9	9	9
Gold Coast Consolidated	2¾	3	2½
Gurum River	20	18	14
Jantar	16	15	15
Jos	15	14	12½
Kaduna	20	18	14½
Kaduna Prospectors	9	10	9
Kano	12½	14	9½
Kuru	9	8	12
Kwall	8	7	5
Lower Bisichi	6¾	6	5¾
Lucky Chance	2	2½	1¾
Minna	3	3	3¾
Mongu	50	50	50
Naraguta	27	28	25
Naraguta Extended	15	14	14
Nigerian Consolidated	–	10¾	10
Ninghi	7	11	7
N.N. Bauchi	40	40	40
Offin River	16	16	–
Rayfield	40	45	50
Ropp	73	56	49
Rukuba	6½	6	–
South Bukeru	10	10	10
Sybu	⅜	1½	1¾
Tin Fields	6	7	6
Federated Malay States:			
Chenderiang	–	73*	–
Gopeng	60	62½	65½
Idris Hydraulic	23	23¾	20¾
Ipoh	11½	14½	14
Kamunting	–	95*	–
Kinta	37¼	38¾	35¾
Lahat	32¾	3[illegible]¾	35¾
Malayan Tin	44½	65½	65½
Pahang	195	189	215½
Rambutan	21	18	18
Sungei Besi	31	32	29
Tekka	36	41½	39
Tekka-Taiping	27	3[illegible]½	36
Tronoh	80	54	21
Cornwall:			
East Pool	59	71	63
Geevor	33½	30¾	33
Grenville	32¾	35	29½
South Crofty	45¾	47½	47¼
Other Countries:			
Aramayo Francke (Bolivia)	147	147	191
Berenguela (Bolivia)	29	31	31
Briseis (Tasmania)	15	24	24
Deebook (Siam)	13	20	26½
Mawchi (Burma)	116	120	100
Porco (Bolivia)	26	25	22
Renong (Siam)	27	35¼	50½
Rooiberg Minerals (Transvaal)	45	60	55
Siamese Tin (Siam)	114	[illegible]	63
Tongkah Harbour (Siam)	73	89	101
Zaaiplaats (Transvaal)	20	22	23

* Three months.

Nigerian Tin Production.
In long tons of concentrate of unspecified content.
Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1915	1916	1917	1918	1919	1920
	Tons	Tons	Tons	Tons	Tons	Tons
January	417	531	667	678	613	547
February	358	528	646	668	623	477
March	418	547	655	707	606	505
April	444	486	555	584	546	440
May	357	536	509	525	483	—
June	373	510	473	492	484	—
July	455	506	479	545	481	—
August	438	498	551	571	616	—
September	442	535	538	520	561	—
October	511	584	578	491	625	—
November	467	679	621	472	536	—
December	533	654	655	518	511	—
Total	5,213	6,594	6,927	6,771	6,685	1,969

Production of Tin in Federated Malay States.
Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1916	1917	1918	1919	1920
	Tons	Tons	Tons	Tons	Tons
January	4,316	3,558	3,149	3,765	4,265
February	3,372	2,755	3,191	2,673	3,014
March	3,696	3,286	2,608	2,819	2,770
April	3,177	3,251	3,308	2,855	2,606
May	3,729	3,413	3,332	3,404	2,741
June	3,435	3,489	2,950	2,873	—
July	3,517	3,253	3,373	3,756	—
August	3,732	3,413	3,259	2,955	—
September	3,636	3,154	3,166	3,161	—
October	3,681	3,436	2,870	3,221	—
November	3,635	3,300	3,131	2,972	—
December	3,945	3,525	3,023	2,413	—
	43,871	39,833	37,370	36,867	15,396

Total Sales of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
August 11, 1919	127½	£17,125	£134 6 5
August 25	130½	£18,297	£140 4 3
September 8	115½	£16,588	£143 12 6
September 22	135½	£19,557	£144 6 9
October 8	72	£10,867	£150 18 7
October 20	32	£5,093	£159 3 2
November 3	34½	£5,235	£151 15 0
November 17	39	£6,161	£157 19 9
December 1	38	£5,905	£155 8 3
December 15	29	£5,133	£176 10 0
December 31	14¾	£2,884	£195 10 10
Total and Average, 1919	2,858	£366,569	£128 5 0
January 12, 1920	31	£6,243	£201 8 0
January 26	51¾	£10,574	£204 6 10
February 9	37½	£7,880	£210 2 8
February 23	53¾	£12,120	£225 10 0
March 8	18	£4,038	£224 7 7
March 22	44	£8,286	£188 6 8
April 6	44½	£8,367	£188 0 5
April 19	33½	£6,375	£190 6 0
May 3	61½	£11,641	£189 5 9
May 17	44	£6,151	£139 16 0
May 31	10	£1,578	£157 16 0

Details of Redruth Tin Ticketings.

	May 3		May 17	
	Tons Sold	Realized per ton	Tons Sold	Realized per ton
		£ s. d.		£ s. d.
Tincroft Mines,	5	192 15 0	5	170 15 0
,, ,,	5½	193 5 0	5	168 15 0
Penryn Minerals	3½	168 15 0	10	128 5 0
,, ,,	6	180 2 6	10	127 10 0
,, ,,	6	180 7 6	8	126 10 0
,, ,,	8	180 12 6	5	147 5 0
Levant	12	198 15 0	—	—
Killifreth	12	200 7 6	—	—
Pendeen	3½	179 0 0	—	—
Trencrom	—	—	1	148 0 0
Total	61½		44	

At the Ticketing held on May 31 the only parcels sold were 10 tons from Tincroft, realizing £1,578.

STOCKS OF TIN
Reported by A. Strauss & Co. Long Tons.

	April 30.	May 31.
	Tons	Tons
Straits and Australian Spot	—	528
Ditto, Landing and in Transit	720	75
Other Standard, Spot and Landing	1,186	3,571
Straits, Afloat	795	1,195
Australian, Afloat	332	
Banca, in Holland	4,167	860
Ditto, Afloat	2,084	2,422
Billiton, Spot		
Billiton, Afloat		187
Straits, Spot in Holland and Hamburg		
Ditto, Afloat to Continent	77	505
Total Afloat for United States	5,610	5,755
Stock in America	2,676	5,356
Total	[illegible]	[illegible]

SHIPMENTS, IMPORTS, SUPPLY, AND CONSUMPTION OF TIN.
Reported by A. Strauss & Co. Long tons.

	April	May
Shipments from:	Tons	Tons
Straits to U.K.	750	[illegible]
Straits to America	3,045	3,755
Straits to Continent	77	
Straits to Other Places	280	343
Australia to U.K.	200	250
U.K. to America	1,355	1,187
Imports of Bolivian Tin into Europe	[illegible]	1,520
Supply:		
Straits	3,872	4,930
Australian	200	250
Billiton	175	238
Banca	1,009	1,366
Standard	[illegible]	835
Total	5,705	7,619
Consumption:		
U.K. Deliveries	1,578	1,826
Dutch ,,		
American ,,	3,305	3,550
Straits, Banca & Billiton, Continental Ports, etc.	385	158
Total	5,268	5,534

[illegible]	[illegible]		
	Africa ...		
May 27	Berenguela Tin	[illegible]	[illegible]
May 26	Broken Hill Block 10	[illegible]	[illegible]
June [illegible]	[illegible]		[illegible]
June [illegible]	Central Mining and [illegible]		[illegible]
June [illegible]	[illegible]	[illegible]	[illegible]
May [illegible]	[illegible]		[illegible]
June [illegible]	Golden Horse-Sho[illegible]		[illegible]
May [illegible]	[illegible]	[illegible]	[illegible]
June [illegible]	[illegible]	[illegible]	[illegible]
June 1[illegible]	[illegible]		[illegible]
June [illegible]	Lonely Reef	[illegible]	[illegible]
May [illegible]	Malayan Tin Dredging	[illegible]	1s. less tax
May 31.	Mexico Mines of El [illegible]	[illegible]	4s. tax free
June 1	Mining Corporation [illegible]	$5.	[illegible] tax
May [illegible]	[illegible]	[illegible]	1s. less tax
June [illegible]	Nevada Consolidated [illegible]	[illegible]	[illegible] cents
June [illegible]	Oroville Dredging	[illegible]	9d. less tax
June [illegible]	Ray Consolidated [illegible]	[illegible]	[illegible]
June 7	Santa Gertrudis	[illegible]	[illegible]
June [illegible]	South African Diamond Corporation	[illegible]	[illegible]
May 14	St. John del Rey...	Pref. £1.	1s. tax free
May 1[illegible]		Ord. £1.	1s. 3d. less tax
June 4	Sungei Besi ...	£1.	1s. less tax
May [illegible]	Tekka-Taiping	[illegible]	3d. on fully paid [illegible] paid, less tax
June [illegible]	Utah Copper	$10	[illegible]
May [illegible]	Zaaiplaats Tin Syndi[illegible]	[illegible]	[illegible]

PRICES OF CHEMICALS. June 8.

		£	s.	d.
Alum	per ton	20	0	0
Alumina, Sulphate of	,,	16	10	0
Ammonia, Anhydrous	per lb.		2	0
,, 0·880 solution	per ton	37	10	0
,, Carbonate	per lb.			7½
,, Chloride of, grey	per ton	60	0	0
,, ,, pure	per cwt.	[illegible]	5	0
,, Nitrate of	per ton	80	0	0
,, Phosphate of	,,	130	0	0
,, Sulphate of	,,	23	10	0
Antimony Sulphide, Golden	per lb.		1	6
Arsenic, White	per ton	70	0	0
Barium Sulphate	,,	12	0	0
Bisulphate of Carbon	,,	60	0	0
Bleaching Powder, 35% Cl.	,,	24	0	0
Borax	,,	41	0	0
Copper, Sulphate of	,,	46	0	0
Cyanide of Sodium, 100%	per lb.			11
Hydrofluoric Acid	,,			7½
Iodine	,,		16	0
Iron, Sulphate of	per ton	4	0	0
Lead, Acetate of, white	,,	[illegible]	0	0
,, Nitrate of	,,	67	0	0
,, Oxide of, Litharge	,,	[illegible]	0	0
,, White	,,	[illegible]	0	0
Lime, Acetate, brown	,,	[illegible]	0	0
,, ,, grey 80%	,,	33	0	0
Magnesite, Calcined	,,	[illegible]	0	0
Magnesium, Chloride	,,	17	0	0
,, Sulphate	,,	12	0	0
Methylated Spirit 64° Industrial	per gal.		6	6
Phosphoric Acid	per lb.		1	9

		£	s.	d.
Potassium Bichromate	per lb.		[illegible]	[illegible]
,, Carbonate 85%	per ton	115	[illegible]	0
,, Chlorate	per lb.		[illegible]	0
,, Chloride 80%	per ton	25	0	[illegible]
,, Hydrate (Caustic) 90%	,,	[illegible]	0	0
,, Nitrate	,,	[illegible]	0	0
,, Permanganate	per lb		[illegible]	[illegible]
,, Prussiate, Yellow	,,		[illegible]	[illegible]
,, Sulphate, 90%	per ton	[illegible]	0	[illegible]
Sodium Metal	per lb.		[illegible]	[illegible]
,, Acetate	per ton	57	0	[illegible]
,, Arsenate [illegible]	,,	60	0	[illegible]
,, Bicarbonate	,,	[illegible]	10	0
,, Bichromate	per lb.		1	11
,, Carbonate (Soda Ash)	per ton	15	0	0
,, ,, (Crystals)	,,	5	10	0
,, Chlorate	per lb.			[illegible]
,, Hydrate, 76%	per ton	[illegible]	0	[illegible]
,, Hyposulphite	,,	[illegible]	[illegible]	[illegible]
,, Nitrate [illegible]	,,	26	[illegible]	[illegible]
,, Phosphate	,,	[illegible]	0	0
,, Prussiate	per lb.		1	[illegible]
,, Silicate	per ton	12	[illegible]	0
,, Sulphate (Salt-cake)	,,	[illegible]	[illegible]	0
,, ,, (Glauber's Salts)	,,	10	0	[illegible]
,, Sulphide	,,	56	[illegible]	[illegible]
Sulphur, Roll	,,	[illegible]	0	0
,, Flowers	,,	[illegible]	[illegible]	[illegible]
Sulphuric Acid, Non-Arsenical, 140°T.	,,	[illegible]	0	[illegible]
,, ,, ,, [illegible]	,,	[illegible]	5	[illegible]
,, ,, ,, 96%	,,	[illegible]	7	6
Superphosphate of Lime, 18%	,,	[illegible]	0	0
Tartaric Acid	per lb		4	0
Zinc Chloride	per ton	[illegible]	0	0
Zinc Sulphate	,,	[illegible]	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	June 6 1919 £ s. d.	June 7 1920 £ s. d.
RAND		
Brakpan	3 15 0	2 11 [illegible]
Central Mining (£8)	9 10 0	8 17 6
City & Suburban (£4)	14 6	6 [illegible]
City Deep	1 1 3	2 7 [illegible]
Consolidated Gold Fields	2 0 0	1 10 0
Consolidated Langlaagte	1 1 6	17 6
Consolidated Main Reef	15 3	11 0
Consolidated Mines Selection (10s.)	1 [illegible] 6	1 4 0
Crown Mines (10s.)	2 5 0	2 8 9
Daggafontein	1 8 0	12 0
Durban Roodepoort Deep	10 0	5 0
East Rand Proprietary	6 9	7 3
Ferreira Deep	13 9	8 6
Geduld	2 13 9	2 0 0
Geldenhuis Deep	12 6	[illegible] 0
Gov't Gold Mining Areas	5 0 0	4 8 6
Heriot	16 3	8 0
Johannesburg Consolidated	1 9 6	1 6 0
Jupiter	5 6	2 3
Kleinfontein	14 6	7 0
Knight Central	7 0	5 9
Knights Deep	9 0	6 3
Langlaagte Estate	1 1 0	14 6
Meyer & Charlton	4 17 6	4 12 6
Modderfontein (10s.)	3 7 6	3 12 6
Modderfontein B	8 10 0	6 7 6
Modder Deep (5s.)	1 18 9	2 10 0
Modder East	—	1 3 9
New State Areas	—	1 7 6
Nourse	17 0	7 6
Rand Mines (5s.)	3 3 9	2 14 0
Rand Selection Corporation	4 1 3	2 15 0
Randfontein Central	14 0	12 6
Robinson (£5)	13 6	8 0
Robinson Deep A (1s.)	18 9	18 9
Rose Deep	19 0	15 6
Simmer & Jack	5 9	5 9
Simmer Deep	3 0	9
Springs	3 0 0	2 3 9
Sub Nigel	1 7 6	15 6
Union Corporation (12s. 6d.)	19 0	19 3
Van Ryn	18 3	16 3
Van Ryn Deep	3 13 9	4 8 9
Village Deep	17 6	10 6
Village Main Reef	14 0	5 6
West Springs	—	15 6
Witwatersrand (Knight's)	1 3 9	15 0
Witwatersrand Deep	13 9	5 6
Wolhuter	4 9	4 9
OTHER TRANSVAAL GOLD MINES:		
Glynn's Lydenburg	1 2 9	10 0
Transvaal Gold Mining Estates	15 6	10 0
DIAMONDS IN SOUTH AFRICA:		
De Beers Deferred (£2 10s.)	[illegible]	22 10 0
Jagersfontein	6 5 0	4 10 0
Premier Deferred (2s. 6d.)	7 15 0	12 5 0
RHODESIA:		
Cam & Motor	5 0	9 0
Chartered British South Africa	1 2 6	16 6
Falcon	14 0	9 9
Gaika	16 6	12 6
Giant	7 3	7 0
Globe & Phœnix (5s.)	1 5 0	14 6
Lonely Reef	2 15 6	3 3 9
Rezende	5 7 6	2 15 0
Shamva	1 18 9	1 16 3
Willoughby's (10s.)	7 0	5 0
WEST AFRICA:		
Abbontiakoon (10s.)	5 0	3 0
Abosso	7 0	12 3
Ashanti (4s.)	1 4 0	17 3
Prestea Block A	4 9	5 0
Taquah	17 0	15 6
WEST AUSTRALIA:		
Associated Gold Mines	4 6	3 6
Associated Northern Blocks	4 0	3 0
Bullfinch	1 9	1 6
Golden Horse-Shoe (£5)	1 15 0	18 9
Great Boulder Proprietary (2s.)	11 0	8 3
Great Fingall (10s).	2 0	2 0
Hampton Properties	—	1 0 0
Ivanhoe (£5)	1 15 0	1 7 6
Kalgurli	11 [illegible]	12 6
Lake View Investment (10s.)	17 6	17 0
Sons of Gwalia	7 0	6 6
South Kalgurli (10s.)	6 [illegible]	4 0

GOLD, SILVER, *cont.*	June 6 1919 £ s. d.	June 7 1920 £ s. d.
OTHERS IN AUSTRALASIA:		
Blackwater, New Zealand	8 9	8 9
Consolidated G.F. of New Zealand	3 9	3 9
Mount Boppy, New South Wales	2 6	4 0
Progress, New Zealand	1 9	1 9
Talisman, New Zealand	12 6	7 6
Waihi, New Zealand	2 3 9	1 18 9
Waihi Grand Junction, New Z'lnd	14 0	11 [illegible]
AMERICA:		
Buena Tierra, Mexico	18 6	10 0
Camp Bird, Colorado	1 2 0	16 0
El Oro, Mexico	1 5 3	12 0
Esperanza, Mexico	16 6	12 3
Frontino & Bolivia, Colombia	8 9	12 6
Le Roi No. 2 (£5), British Columbia	11 3	10 0
Mexico Mines of El Oro, Mexico	7 10 0	6 7 6
Nechi (Pref. 10s.), Colombia	11 6	8 9
Oroville Dredging, Colombia	1 8 0	1 5 0
Plymouth Consolidated, California	1 6 3	18 9
St. John del Rey, Brazil	19 0	17 0
Santa Gertrudis, Mexico	1 9 [illegible]	1 6 0
Tomboy, Colorado	16 6	10 9
RUSSIA:		
Lena Goldfields	1 15 0	1 0 0
Orsk Priority	17 6	10 0
INDIA:		
Balaghat (10s.)	4 3	8 9
Champion Reef (2s. 6d.)	5 9	3 0
Mysore (10s.)	2 0 0	16 3
North Anantapur	3 6	4 0
Nundydroog (10s.)	18 3	13 0
Ooregum (10s.)	16 0	14 3
COPPER:		
Arizona Copper (5s.), Arizona	1 17 6	[illegible] 6 3
Cape Copper (£2), Cape and India.	2 5 0	1 2 6
Esperanza, Spain	6 0	5 9
Hampden Cloncurry, Queensland	17 0	15 0
Mason & Barry, Portugal	2 13 9	1 10 0
Messina (5s.), Transvaal	5 0	5 6
Mount Elliott (£5), Queensland	3 10 0	2 5 0
Mount Lyell, Tasmania	1 2 6	1 4 3
Mount Morgan, Queensland	1 5 0	1 1 3
Mount Oxide, Queensland	5 0	3 9
Namaqua (£2), Cape Province	1 17 6	1 10 0
Rio Tinto (£5), Spain	59 0 0	55 10 0
Russo-Asiatic Consd., Russia	—	10 6
Sissert, Russia	1 2 6	11 3
Spassky, Russia	1 12 6	1 0 0
Tanganyika, Congo and Rhodesia	4 11 3	1 16 3
LEAD-ZINC:		
BROKEN HILL:		
Amalgamated Zinc	1 5 9	1 6 [illegible]
British Broken Hill	1 17 6	2 0 0
Broken Hill Proprietary (8s.)	2 4 6	3 3 9
Broken Hill Block 10 (£10)	1 7 6	1 3 9
Broken Hill North	2 8 9	2 12 6
Broken Hill South	2 5 0	2 13 9
Sulphide Corporation (15s.)	1 1 6	17 6
Zinc Corporation (10s.)	1 1 6	18 0
ASIA:		
Burma Corporation	6 15 0	9 0 0
Russian Mining	1 2 6	10 0
RHODESIA:		
Rhodesia Broken Hill (5s.)	13 9	11 9
TIN:		
Aramayo Francke, Bolivia	3 10 0	3 15 0
Bisichi, Nigeria	15 0	12 0
Briseis, Tasmania	5 3	4 9
Dolcoath, Cornwall	13 0	3 0
East Pool (5s.) Cornwall	17 9	10 0
Ex-Lands Nigeria (2s.), Nigeria	3 0	3 6
Geevor (10s.) Cornwall	19 0	11 3
Gopeng, Malay	2 6 3	1 18 9
Ipoh Dredging, Malay	1 2 6	16 3
Kamunting, Malaya	2 6 3	2 10 0
Kinta, Malaya	2 11 3	2 10 0
Malayan Tin Dredging, Malay	2 10 0	2 0 0
Mongu (10s.), Nigeria	19 0	17 6
Naraguta, Nigeria	17 6	11 3
N. N. Bauchi, Nigeria (10s.)	7 0	5 0
Pahang Consolidated (5s.), Malay.	17 6	10 6
Rayfield, Nigeria	5 0	9 3
Renong Dredging, Siam	2 5 0	2 2 6
Ropp (4s.), Nigeria	1 3 9	9 9
Siamese Tin, Siam	3 6 3	3 10 0
South Crofty (5s.), Cornwall	1 10 0	12 0
Tehidy Minerals, Cornwall	13 6‡	17 6
Tekka, Malay	4 5 0	5 5 0
Tekka-Taiping, Malay	4 17 6	1 6 3
Tronoh, Malay	1 18 9	2 1 3

‡ 10s. paid up.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

METALLURGY AT THE CONNEMARA GOLD MINE, RHODESIA.

The January *Journal* of the Chemical, Metallurgical, & Mining Society of South Africa contains a paper by B. L. Gardiner describing the treatment of a troublesome oxidized gold ore, occurring in the Banded Ironstones at the Connemara mine, Southern Rhodesia. The novelty of treatment consists of giving the ore a preliminary heating at a lower temperature than that of roasting, whereby the recovery by the cyanide process is greatly increased at little expense. The result of this heating is to decompose hydrated oxide of iron by expelling the water of combination and thus permitting the cyanide to get into contact with the gold.

The process, which, for the want of a better name, has been termed the "baking process," consists merely in heating the ore before cyanide treatment. It differs from the ordinary roasting process in that the degree of temperature to which the ore is raised is much lower than that necessary for the roasting, and further that the presence of air or oxygen is in no way essential to its success, the application of a certain amount of heat being all that is needed. The net result of the introduction of the baking system at the Connemara Mine has been to increase the extraction from 68% to 86%, with little or no increase in the working costs.

The ore of the Connemara Mine belongs to the class known in Rhodesia as Banded Ironstones, and at present only the upper oxidized portions of the lodes are being worked, and it is solely with this oxidized ore that the paper treats. The author quotes extracts from a petrological report by M. Weber, which indicate the more important minerals present and also the nature of the occurrence of the gold.

"C.A. Rich Ore 185 ft. N. 1st Level E. Reef; Oxidized Banded Ironstone. A fine-grained mosaic of quartz grains, contains large quantities of iron oxides and some iron hydroxides, which have penetrated every fracture of the rock. Portions of the rock consist of secondary quartz infiltrations. These quartz veins have been fractured, granulated, and invaded by iron oxides to such an extent that it is often not possible to distinguish them from the original rock material. Minute gold grains were also found in some iron oxides within the rock material.

"C.C. No. 1 Level E. Reef Drive 100 ft.-150 ft.; Oxidized Banded Ironstone. A fine-grained rock consisting of alternating layers of iron oxides and granulated quartz. The section shows a series of fractures running almost normal to the bedding plane. Younger than these quartz-filled fractures, is a contorted band of hydrated iron oxides which contain some grains and groups of grains of gold. The gold occurs either in or on the contorted line, which appears to have been one of the channels which collected and admitted the solutions from which the secondary gold has been precipitated."

Besides the silica and iron oxides which make up the bulk of the ore, qualitative analysis shows the presence of combined water, magnesia, and sulphates. In the upper parts of the lodes, crystals of magnesium sulphate are occasionally to be seen growing on exposed faces. In the lower portions, near or on the contact with the sulphide ore, crystals of ferrous sulphate are common, and also the various stages of oxidation to ferric sulphate.

The original plant consisted of twenty 1,250-lb. gravity stamps, and one 5 ft. Chilean mill as crushing units, followed by sand leaching and slime decantation plants, the gold being recovered by amalgamation on copper plates and by zinc-shaving precipitation of the cyanide solutions. Ultimately it was found that the best commercial results were obtained by using 200 screening on the mill (aperture 0·0566 in.). The average results over a period of 12 months are given here, the tonnage varying between 4,000 and 4,500 tons per month.

	Dwt. per ton	Recovery %
Average value of the milled ore (Screen sample)	6·76	
Average value of mill tail .... (Calculated from values of sand and slime).....................	5·87	
Extraction by amalgamation......	0·89	13·2
The pulp consisted of...Slime = 33% Sand = 67%		
Average value of sand charges	6·07	
Average value of sand residues...	2·30	
Extraction on sand	3·77	62·1
Average value of slime charges	5·47	
Average value of slime residues	1·90	
Extraction on slime	3·57	65·3
The total recovery on the whole treatment working out to..		67·9

The gold recovered over the same period gave a small surplus over the total gold called for. Such a poor extraction (barely more than two-thirds of the gold contained in the ore) could not be looked upon as very satisfactory, and experimental work has been constantly carried on with a view to devising some possible working process whereby improvement might be brought about. Re-treatment of residues failed to recover any more gold, and laboratory tests, on the whole, merely tended to show that the plant was doing all that could be expected of it. It was certainly an unusual state of affairs for a completely oxidized ore such as that being treated to fail to yield a much greater proportion of its gold than that indicated by the results given.

The gold in the ore is very finely divided, and by panning a crushed sample of ore worth 7 dwt. by assay a "prospect" of about 1 dwt. only is visible, and that very fine gold. In practice it was found, as stated, that a 200 screen (0·0566 aperture) gave the best commercial results, finer comminution than this leading to a very small additional extraction only, a circumstance which may be explained by the fact that the distribution of the gold in the sand is in greater proportions in the fine, as is shown in the following sizing analysis of a sand charge:

CHARGE AVERAGING 6·7 DWT. GROUND TO 400 SCREEN.

	%	dwt.
+ 40	9·0	3·2
— 40 + 60	21·1	4·2
— 60 + 100	21·6	4·3
— 100	48·0	1·0
	99·7	6·9

The coarser sizes show more silica, and the finer more iron oxides. A sizing of sand residue illustrates that the unrecovered gold is also mainly in the finest particles.

[illegible]

Charge, 9·6 dwt.; Average of Residue, 3·0 dwt.; 300 screen, Recovery, 68·7%.

[illegible]

The cyanide practice presents little or no difficulty, the ore being completely oxidized and free from any reducing or oxygen-absorbing compounds, the occurrence of ferrous sulphate already mentioned being very restricted and not having any noticeable effect. Without the addition of lime, there is excessive consumption of cyanide, and this has been attributed to the action of ferric sulphate or basic iron sulphates, which may be expressed in a general way by the equation:

$$Fe_2(SO_4)_3 + 6KCN + 6H_2O = 6HCN + 2Fe(HO)_3 + 3K_2SO_4.$$

By the addition of sufficient lime the abnormal destruction is arrested, and the cyanide consumption reduced in practice to ½ lb. of NaCN per ton for the sand treatment, and 1 lb. per ton for the slime. The consumption of lime is high, being from 6 to 8 lb. per ton of CaO. The working solutions of the cyanide plant are singularly pure, qualitative analysis indicating besides the cyanide and lime, zinc salts and traces of sulphates. Ferro-cyanides and sulphocyanides are conspicuously absent. Precipitation is good, provided that the sand solutions are maintained at 0·06% KCN and the slime solutions at 0·05% KCN, the latter condition making the consumption for the slime treatment higher than it might otherwise be.

Many experiments had been conducted with a view to increasing the extraction, such as finer grinding, aeration, oxidizers, concentration, longer treatment, stronger solutions, preliminary acid washes, etc., but all failing to make any practical improvement. A further peculiarity is that ore from some parts of the mine yields better results than that from other parts, the extraction in some months being as low as 63% and in others as high as 72%, a condition of affairs which makes comparative test work doubly difficult. This is the best explanation that can be offered for several inconsistencies that may disclose themselves in the records of experiment which are tabulated.

During one poor-extraction month (62·9%) residues were going out higher than usual, and the possibility of re-precipitation in the ore presented itself. As a sort of indirect test for this a sample of sand residue was roasted in the muffle furnace; this sand was re-treated with cyanide, giving the following remarkable result:

Original assay value	7·0 dwt.
Assay of residue	2·8 dwt.
Recovery	60%

A number of tests (A to H) were then undertaken.

Test A.—The residue was roasted and then intermittently agitated in a bottle with cyanide solution over 48 hours, washed, dried, and assayed again. Assay of final residue, 0·5 dwt.; total recovery on 7·0 dwt., 92·8%. It was incidently observed that on roasting, the colour of the ore had changed from a dark earthy to the colour of red ochre, which was very significant, in view of the greatly altered nature of the ore. Further tests were then initiated. They are, except where otherwise stated, bottle agitation tests, and are aimed at obtaining the maximum gold solubility figure for the ore under the various conditions. A ratio of 2 : 1 for solution to ore was used, also excess of lime, and at least 48 hours agitation. The sample was then thoroughly washed with an excess of water and finally dried and assayed:

Tests B.—The following table gives results of three tests:

	Dwt. in Charge	Dwt. in Residue	Recovery
B.—Roasted in muffle with stirring	9·5	0·5	94·7
B_2—Sand placed in a graphite crucible covered and brought to red heat in coke furnace	9·5	0·5	94·7
B_3—Sand placed in sample tin covered and baked over "Primus" stove	9·5	0·6	93·7

The actual residue obtained from this charge in the sand plant was 3·5 dwt., or 63·1% recovery. The logical deduction from the above test was that some vital change had taken place in the ore, by the application of heat. From the knowledge of the constituents of the ore, this could be two things: (1) decomposition of sulphates, or (2) decomposition of hydrates. The fact, as illustrated in Test B_3, that a temperature below red heat is all that is necessary, inclines one to the idea (2), as also does the change of colour, the latter being reasonably attributable to the formation of Fe_2O_3 from hydrated oxides of iron. After being baked, the ore, while hot, is quite black, and gradually changes to the red on cooling, a well-known characteristic of ferric oxide. Heated in a test tube, a well-dried sample of the ore yields a relatively large quantity of water, which condenses freely on the cold part of the tube and visibly escapes as condensed steam from the open end.

Test C gives some idea of the volatile proportion of the ore. 20 grams of ore was crushed to 60 mesh, ignited in muffle at red heat; weight after ignition 18·9 grams, loss 1·1 grams = 5·5%; SO_3 determined on same sample, 0·17%; CO_2 determined on same sample, trace. Evidently the greater part of the loss is accounted for as H_2O.

Test D.—The sample of ore was crushed to pass 1½ in. aperture screen, assay 8·0 dwt.

D_1—Crushed through 300 screen (aperture 0·04 in.), agitated with cyanide solution:

Original value	8·0 dwt.
Residue value	3·4 dwt.
Recovery	57·5%

D_2.—Sample placed in closed vessel provided with small holes for steam to escape and then allowed to remain in the escaping gases of a boiler flue for 12 hours; then removed and ore crushed through 300 screen and treated as in E.1.

Original value	7·7 dwt.
Residue value	0·8 dwt.
Recovery	89·7%

The temperature of the boiler flue in question lies between the melting point of solder (say 190°-200°C.) and the melting point of lead, 327°C.

Evidently the temperature necessary to bring about the required decomposition is somewhere between 200° and 327°, much less than that required to roast a sulphide ore. A sample of the ore baked in the boiler flue loses a further 2% on ignition and gives off more water, so it is apparently not necessary to completely drive off all the combined water in order to get good results.

Test D_3.—Sample of ore *E* crushed through 300 screen first and then baked in flue of boiler for 12 hours, then cyanided as in D_1 and D_2:

Original assay	7·2 dwt.
Residue assay	0·8 dwt.
Extracted	6·4 dwt.
Recovery	88·8%

This test established a further fact, that the baking is as satisfactory on ore as coarse as 1½ in. aperture as it is with minus 0·04 inch aperture.

Test E.—Lumps of ore passing 2 in. ring and not passing one inch. The pieces baked by placing in flame of "Primus" stove till colour changed.

Crushed through 40 mesh screen. Cyanided.

Original assay	5·6 dwt.
Residue assay	[illegible] dwt.
Extracted	5·1 dwt.
Recovery	91%

Test F.—Similar sample to *E*. Baked in dish over Primus stove for half an hour. Crushed through 20 mesh sieve and cyanided.

Original assay	6·2 dwt.
Residue assay	0·9 dwt.
Extracted	5·3 dwt.
Recovery	85·5%

Test G.—General sample of ore as coming from rock-breaker station (large ore and fine mixed). Baked at temperature less than dull red for 15 minutes. Crushed through 300 battery screen and cyanided.

Original value	11·0 dwt.
Residue value	1·2 dwt.
Extraction	9·8 dwt.
Recovery	89·1%

Tests *E*, *F*, and *G* evidence that very good extractions can be obtained by baking large lumps of ore, and with by no means excessive or prolonged heating.

It was further apparent from some of these tests, which consist of direct cyanide treatment only, that preliminary amalgamation is not a necessity for good extractions, evidently the gold being sufficiently fine to dissolve in cyanide solutions in a reasonable time.

As it had been demonstrated that the ore could be satisfactorily baked in regard to coarseness, further tests were now made with a view of determining with what degree of coarseness it could be satisfactorily cyanided.

Test H.—Ore crushed through screen containing three holes to the inch (0·25 in. aperture). Baked at less than red heat for ½ hour. Four days intermittent agitation. A recovery of 87·9% was obtained; the sizing analysis of the charge and the residue show that approximately the same percentage of recovery is obtained on all degrees of fineness.

Sizing analysis of ore before treatment:

Mesh	%	Dwt.
- 10	54·5	8·0
10 - 14	11·0	8·0
- 14 + 40	13·2	11·0
40 - 100	10·0	11·0
- 100	11·3	13·0
	100·0	9·26

Sizing analysis after treatment:

Mesh	%	Dwt.
+ 10	58·2	1·0
10 - 14	11·2	1·0
- 14 - 40	12·0	1·3
- 40 + 100	12·0	1·3
-100	11·0	1·6
	99·9	1·12

It was eventually decided to erect a plant suitable for treating ore on a working scale, and for this purpose a rotary drier was installed. The drier consists of a tubular shell of ⅝ in. boiler plate, 32 ft. long and 5 ft. diameter, made in five sections and set at an inclination of 1 ft. in 16 ft., or a total fall of two feet over its whole length. The shell revolves about its central axis and is supported on six rollers, the turning action being communicated through a large spur wheel round the periphery of the tube, and is arranged to make one revolution in 45 seconds. The feed is led in through a 6 in. pipe at the higher end and gradually travels down to the lower end, where the fire box is situated, and is there discharged into a small hopper provided with a discharge door. The interior of the drier is divided by means of steel plates set radially into four sectors for the first 18 ft. of its length, and the last 12 ft. is lined with fire-brick at the end nearest the fire box. The fire-box in which wood fuel is burnt has a grate area of 21 square feet. The tube at the far end from the fire enters a brick dust-settling chamber, which finally leads to a smoke stack, the whole arrangement being such that the ore travels counter-current to the hot gases from the fire. The baked ore is transported from the drier in trucks and dumped directly into sand vats for treatment. The possible charring effect of the hot ore on the filter bottoms and of damage to the tanks is overcome by covering the bottom with an inch or two of solution before dumping, and then, as the quantity of ore increases, by pumping in more solution so as to keep the hot ore from direct contact with the tank. In this way the dusting that results from the dropping of hot ore into the solution is kept at a minimum as each succeeding truck load is dumped on to the apex of the cone of ore in the tank and only a little at a time slides quietly into the standing solution.

At the outset of operations, it was decided to use 10 stamps to reduce the ore to sufficient fineness to be suitable for feeding to the drier, the ore to be classified into sand and slime and the sand only to be baked. This was done, and several trial runs were made, with the stamps crushing through ¼ in. aperture screens and the coarse sand then baked and cyanided. The extraction results were fair, ranging from 77·4% to 85%, but the duty of the drier was found to be small under such conditions, owing to the moisture carried by the sand. It seemed to take more heat to drive off the moisture than to raise the ore to the necessary temperature, and on the whole could not be termed an entire success.

Concurrently with the tests on the working scale, laboratory experiments were being further conducted to determine the extreme limit of coarseness to which successful cyaniding might be applied. Since the inception of ordinary milling operations, it had been the practice at the time to separate out the fine by passing the ore, as it leaves the rock-breaker, over a shaking screen, provided with screening of 1½ in. aperture. This fine it was customary to feed directly to the Chilean mill. Experimental work with this *minus* 1½ in. product gave extraction results averaging 85%, and it was therefore decided to cut out the Chilean mill and feed the whole of the fine to the drier and then directly cyanide without further comminution. The scheme was immediately put into practice. At first results were very varied, but control and test investigations soon showed that the fault lay with insufficient time of treatment in the cyanide, and steps were taken to provide more vat capacity. This done, the residues fell to a uniformly lower figure, and by close attention to details an average extraction of over 80% has finally been obtained.

So far only the fine, eliminated after the rock-breaker, has been subjected to baking, the balance of the ore going through the ordinary process of milling, amalgamating, and cyaniding of sand and slime. A peculiar feature in the nature of the ore is that the fine is much higher in gold contents than the coarse, and the sizing brought about by passing over the shaking screen causes a considerable amount of concentration. A practical example is the best illustration. During the months June, July, and August, 1918, 12,047 tons of ore, valued at 5·77 dwt., was raised from the mine and treated. After passing the screen (1½ in. aperture), two products, the fine ore and the coarse ore, were made in the following quantities and values:

Fine ore:	4,337 tons of 8·57 dwt. = 1,858·2 oz.
Coarse ore:	7,710 tons of 4·23 dwt. = 1,631·2 oz.
Total	12,047 tons of 5·77 dwt. = 3,478·8 oz.

Thus, it will be seen that the fine ore, which amounts to little more than one-third of the whole tonnage, contains more than one-half the total gold contents.

The whole treatment of the fine ore is as follows: After the separation on the shaking screen the ore is led into a storage bin, whence it is fed into the drier by way of the feed pipe at an even rate, and gradually travels down to the discharge end, the time occupied in traversing the full length being estimated at about 30 minutes. The ore gradually takes up heat, and by the time it falls into the discharge hopper it is sufficiently baked for the subsequent treatment. It now presents a soot-black appearance, and is usually accompanied by a crackling noise as the result of numerous small explosions, which may be due to unequal strains caused through the heat, or, what is more likely, to the sudden eruption of imprisoned steam. Periodically, the hopper is emptied into trucks and transferred to the cyanide treatment tanks, slacked lime being added regularly to each truck. On cooling, the ore turns to a bright red colour, characteristic of ferric oxide, Fe_2O_3.

During the filling, strong cyanide solution (0·17%) is pumped on as needed to keep the hot ore from direct contact with the tanks, finally covering when a charge is levelled off. Contact takes place for twelve hours, and then the whole charge is drained off, and another strong solution pumped on. Subsequent treatment consists of pumping on washes of 0·6% sump solution, giving alternate contact and draining. It is important to drain out completely every charge of solution, as residue assays show that more rapid and better extractions are obtained in this way than by continuous percolation. The time of treatment averages 10 days, and the total quantity of solution in tons is at least $1\frac{3}{4}$ times the tons of ore treated. No difficulties are met with in the cyanide plant, other than the high consumption of lime, which is rather greater than that consumed by the unbaked ore, amounting to 10-12 lb. per ton in terms of pure CaO.

The following is a sizing analysis of a sample of the fine baked residue:

ASSAY VALUE OF RESIDUE.

Mesh	%	Dwt.
+ $\frac{1}{2}$ in.	26·9	1·2
−$\frac{1}{2}$in. + $\frac{1}{4}$ in.	14·9	1·6
$\frac{1}{4}$ − 10	31·3	1·6
− 10	26·9	1·6
	100·0	1·49

In mass it has the appearance of rather coarse gravel, some of the lumps being as large as walnuts, and then all sizes, as the above test shows. With such material, there is, of course, not the slightest difficulty in obtaining good percolation.

The treatment figures on the baked ore for the three months June-August, 1918, are given herewith.

BAKED ORE TREATMENT.

Month	Fine Ore Before Baking		Fine Ore After Baking			Residues		Gold Called For
	Tons	*Assay dwt.	Tons	Assay dwt.	Gold contents oz.	Assay dwt.	Gold contents	Oz.
June	1,417	7·6	1,252	8·0	506·0	1·0	67·6	438·4
July	1,360	8·2	1,387	8·7	603·9	1·09	76·1	527·8
August	1,560	9·5	1,482	10·0	748·3	1·49	110·5	637·8
	4,337	8·57	4,121	9·01	1,858·2	1·23	254·2	1,604·0

* Obtained by calculation allowing 5% loss in baking. Theoretical extraction, 86·3%.

It has not been convenient to keep the gold won from the baked ore separate from the gold won by cyanide from other sources, but over the whole period the total gold won tallies very closely with the theoretical call, and it is a fair assumption that the gold yield confirms the assay figures given above. The actual call and recoveries for the three months were:

	Gold called for	Gold recovered
	oz.	oz.
June	919·6	861·8
July	837.5	862·1
August	742·0	750·5
Totals	2,499·1	2,474·4

On the Connemara Mine it has not been the practice to keep segregated costs, but a liberal estimate of the average expenditure works out at about 1s. 10d. per ton for the actual roasting, and including transport to and from the drier to about 2s. 2d. per ton. The principal item is fuel, from five to six cords a day being consumed when running, and amounting to 1s. 3d. per ton baked. Power is estimated at 3 to 4 h.p., other items, European and native labour, oils, repairs, and renewals making up the balance. With a plant designed and arranged specifically on the baking lines, no doubt costs could be very considerably reduced. The heat efficiency could be greatly increased also by lengthening the drier, with a consequent reduction in the fuel bill. Such improvements in this instance have been so far limited by financial considerations, for they would mean remodelling a large section of the existing plant. As things are, the baking does not cost more than the Chilean mill, which it supplanted, and so the improved extraction amounts to so much net gain to the working profit.

Proposals have been made for treating the whole of the ore by baking and several different schemes offer themselves for consideration. One of them is to bake the large ore first, and then to crush in the stamp-mills, preparatory to cyaniding. An experimental furnace built on the lines of an outside-fired lime-kiln has been erected, the hot gases from the fire being made to pass up through the broken rock. As it becomes baked the ore is drawn off from the bottom, while more ore is fed in at the top, the furnace or kiln thus being continuous in action. So far, only short trial runs have been made, but they proved that the ore could be baked well, and laboratory tests have given improved extractions. Two reasons, however, have precluded the continuation of this scheme for the present. One is, that on a grade of 4 dwt. the extra extraction obtained by baking does not mean so much in hard cash, and the probable margin over the cost of baking, which is here an extra charge, is consequently small. The other is, that difficulties with the fuel supply render it advisable to conserve wood as much as possible.

In finally discussing the metallurgical side of the process, some explanation is called for to account for the greatly improved extractions obtained after the ore has been subjected to the application of a moderate degree of heat. It has been pointed out that the ore contains considerable proportions of hydrated oxides of iron and that, when heated, appreciable quantities of water are given off. This water, it must be understood, is not present as moisture, since it will not be driven off in a water bath at 100°C., but requires a somewhat higher temperature, and it is evident that it exists in the ore as water of combination. The petrological report already quoted shows that the gold exists closely associated with the hydrated oxides, and no doubt much of the gold is due to secondary deposition, as the oxidized portion of the ore-body is markedly higher in value than the sulphide portion, the latter, in fact, being unprofitable to work. Be the origin of the gold what it may, there is no doubt that it is coated or locked in some way so as to be inaccessible to cyanide solutions, and the most likely substances among the constituents of the ore to bring about such a condition are the hydrated iron oxides. In all the old dumps of sulphide ore lying on the surface can be seen the peculiar cementing action of these secondary products from iron sulphides, caused through the ordinary weathering by atmospheric agencies. On digging into these dumps, not more than five to six years old, large masses can already be found bound together by the cementing action of the hydrated oxides, individual lumps appearing as if glazed over with some rusty coloured varnish. It is well known, of course, that if limonite and minerals of similar constitution are heated sufficiently, they will yield up the water and remain as ferric oxide (Fe_2O_3) in the form of a very fine and porous powder; in fact in an ideal form for cyanide solutions to penetrate and leach out any gold which may be commixed. Such action as this is doubtless what takes place in the ore when it is baked, and the theory readily explains the improved extractability of the ore. That the gold can be dissolved out of such large pieces as are now actually being treated depends also to a great extent on the increased porosity of the ore caused by the dehydration, but it is assisted greatly by the structure of the ore.

In hand specimens the appearance does not by any means give the impression of any great porosity; if anything, the reverse; but the rock sections apparently show that it is much crushed and contains numerous minute channels for the most part filled with hydrated oxides of iron. A simple test which shows the porosity of the ore is the following. If a piece of baked ore, say, as large as a man's fist, is baked and then, after cooling, is placed in a vessel of water, minute bubbles can be seen rising from it, much the same as those seen when an ordinary red brick is immersed. If, after standing a minute or two, the piece is removed and broken up, it will be found that the interior is wet all through, which shows that water can penetrate to every part of it, and practical results have shown that cyanide solutions, given sufficient time, can dissolve out a large proportion of the gold contents. The one other feature that calls for special remark is the fact that the coarse, or what is better termed in this case, the visible gold, does not seem to hinder the cyanide extraction to any known extent. In the ordinary treatment some 13% of the gold is recoverable by amalgamation, but in the baking treatment all this is recovered by cyanide. A special test was made by collecting some of the free gold by panning and transferring to a glass beaker with 0·25% cyanide solution. The beaker was shaken up at irregular intervals, only during the day, and allowed to stand over night, and on the fourth day all the gold had disappeared into solution. It must be admitted, however, that all the visible gold is very fine, much finer in fact than that usually met with.

CLASSIFICATION OF TIN AND TUNGSTEN DEPOSITS.

In the last issue of the Magazine were produced the argumentative portions of Dr. W. R. Jones's paper read before the Institution of Mining and Metallurgy in March on the relative occurrence in depth of tin and tungsten ores. We mentioned that it was impossible on that occasion on account of want of space to give Dr. Jones's classification of the world's deposits into his five genetic divisions. We give this part of his paper herewith.

Tin and tungsten deposits could be classified on a mineralogical basis, the different classes being distinguished by the important mineral associates. Thus reference might be made to the cassiterite-wolframite-tourmaline class, the wolframite-pyrites class, to the scheelite-silver class, and so forth. No detailed classification of the world's deposits on these lines exists so far as the author knows, and although possibly useful, such a classification would not be as satisfactory as a classification based on the mode of occurrence of such deposits. In this latter classification all the deposits can be resolved into five classes; such classes do not overlap as would be the case in a classification on a mineralogical basis; some of the classes merge into one another in a natural way; and it can frequently be deduced what minerals are likely to occur in any particular type of deposit, once its mode of occurrence is known. There are, at least, two other strong reasons for deciding on this, as against any other, basis of classification. The first reason is that it is founded on field-evidence of a general character, and can therefore be applied to any particular deposit by the observer in the field. It is not dependent on the microscopic examination of very small fragments of rocks which may be supposed to be representative of one or more veins, or even of a series of veins, nor is it dependent on a few analyses of selected minerals which may, or may not, be representative of the deposits. To illustrate the unreliability of a classification of the deposits now under consideration, when founded on examinations of some microscope slides and a few chemical analyses, there is the striking case of the wolframite deposits of Tavoy, Lower Burma, which were stated (Dr. Bleeck, *Rec. Geol. Surv. India*, vol. xlviii, 1913, p. 48) to carry columbite and tourmaline in abundance. Notwithstanding the strenuous efforts of the officers (J. Coggin Brown and A. M. Heron, "The Distribution of Ores of Tungsten and Tin in Burma," *Rec. Geol. Surv. India*, vol. l, part 2, 1919, pp. 101–121) of the Geological Survey of India, and of other geologists (W. R. Jones, "The Origin of Wolfram in the Tavoy District, Burma," *Lect. Govt. Min. Advis. Board*, Sept., 1917; J. Morrow Campbell, "The Ore Minerals of Tavoy District, Burma, *Lect. Govt. Min. Advis. Board*, June, 1918) during the last four years in the Tavoy District, during which time the deposits have been worked more extensively and intensively than in previous years, not a single specimen of columbite has been found, and tourmaline is now known to be present only as a rare mineral. The second reason is that their mode of occurrence appears to correspond to the relative zones of temperature of formation of the deposits, so that in classifying them on this basis we are presented at the same time with information which furnishes interesting, if speculative, evidence as to their probable persistence or non-persistence in depth.

The author divides tin and tungsten deposits into five classes as follows: 1. Segregation Deposits. 2. Contact-Metamorphic Deposits. 3. Pegmatoid Deposits. 4. Quartz Vein Deposits. 5. Replacement Deposits. A word is necessary as to the names given to the five classes. For that in which the tin and tungsten minerals occur as primary minerals in the ordinary granite the term "segregation deposits" appears to be suitable and descriptive. Under "pegmatoid deposits" are included, besides pegmatite veins, other minor igneous intrusions like aplites, quartz-porphyries, and rhyolites. There is no object in separating them, for the difference between an aplite and a granite-pegmatite, for example, is essentially merely one of degrees of coarseness of crystallization. Although pegmatite veins and quartz veins of magmatic origin are known in nature to merge into one another, it has been found convenient to separate the two deposits, because the temperature of formation of some pegmatite veins is known to be higher than that of some of these quartz veins. "Contact-metamorphic deposits" is a descriptive term for those formed at, and near, the igneous contact. It has been difficult to decide what name to give to the fifth class, and the author would welcome a better name than "replacement deposits." The segregation, the contact-metamorphic, and the replacement deposits are of little economic importance. Moreover, it appears doubtful whether it has been clearly established that there exist any deposits of tin and tungsten minerals that are true replacement deposits. The author feels compelled, however, to classify five small occurrences as such, because they have been so described by the observers in the field. Great difficulty has been experienced in obtaining descriptions of ore-bodies of some tin and tungsten fields, and especially of the latter, so that the mineral associates are not, in some cases, as complete as is desired

Segregation Deposits. The following deposits are included in this class:

Near Rawang and other parts of the Federated Malay States (W. R. Jones, "Mineralization in Malay," *Mining Mag*., Oct., 1915). A little cassiterite occurs disseminated in a few patches in granite, but the deposits are of no economic importance. Tourmaline is present.

On Sheffield Mine (W. R. Jones, "The Origin of Wolfram," *Lecture Govt. Mining Advisory Board, Tavoy, Burma*, Sept., 1917) and other parts of Tavoy District, Burma (J. Morrow Campbell, "The Ore Minerals of Tavoy District," *Lecture Gov. Mining Advisory Board*, June, 1918, p. 8). A little wolfram and cassiterite is disseminated through the granite, and some concentrates have been obtained from the weathered granite. Tourmaline and topaz are absent.

In Ross-shire, Scotland (J. J. H. Teall, *Summary of Progress, U.K. Geol. Surv*., 1905). A little cassiterite has been found in association with magnetite in a magnetite-cassiterite rock which is probably formed by segregation in granite. The cassiterite is distributed in a sporadic manner, varying from 0% to 17% of the magnetite-cassiterite rock. No minerals containing boron or flourine have been found either in the segregation or in the granite with which it is associated. It is the only known occurrence of cassiterite in Scotland, and has not been proved to be of economic importance.

On the Henault Property, near Lead, S. Dakota (J. J. Runner and M. L. Hartmann, "The Occurrence, Chemistry, Metallurgy and Uses of Tungsten," Rapid City, S. Dakota, Sept., 1918). Crystals of wolframite have been found intergrown with quartz and felspar in a rhyolite-porphyry, the wolframite apparently having segregated out from the magma and concentrated near the margin of the dyke.

In the Whetstone Mountains, Cochise County, Arizona (F. L. Hess, "Tungsten Minerals and Deposits," *U.S. Geol. Surv. Bull*., No. 625). Wolframite, in small flat crystals, is distributed through the granite near the quartz veins. A few tons of concentrates have been produced from the deposit.

At Bamford, Queensland (J. J. Runner and M. L. Hartmann, "The Occurrence, Chemistry, Metallurgy, etc, of Tungsten," Rapid City, S. Dakota, Sept., 1918; R. H. Rastall, "The Genesis of Tungsten Ores," *Geol. Mag*., 1918). Wolframite occurs as an original constituent of granite (pegmatite, greisen, and quartz veins are also present). Wolframite, bismuth, bismuthinite, molybdenite, pyrites, chalcopyrite, blende, and galena are present, and cassiterite is rare. Tourmaline appears to be absent.

It is interesting to point out that Beck (Beck, *Zeitschr. Kryst. Min*., vol. xxxiii, 1900) considers that cassiterite also occurs as a primary mineral in the granite of Banca and Billiton, Dutch East Indies; and he also states it is a microscopic constituent of the Eibenstock Granite. Von Micklucks-Maclay (M. von. Micklucks-Maclay, *Neus. Jahrb*, 1885, Band 2, p.88) states that cassiterite occurs as an inclusion in the mica of a granite and is associated with rutile, topaz, apatite, and tourmaline. Cassiterite is also known to occur in some of the Cornish granites (Clement Reid, "Geology of Newquay," *Mem. Geol. Surv. of England & Wales*, No. 346). and tourmaline is associated with it.

Contact-Metamorphic Deposits. The following come under this classification:

At Seven Troughs, Nevada (F. L. Hess, "Tungsten Minerals and Deposits," *U.S. Geol. Surv. Bull*., No. 652). Granite is stated to be replaced by epidote, scheelite, and other minerals.

At the South-end of Trinity Range, near (F. L. Hess, "Tungsten Minerals and Deposits," *U.S. Geol. Surv. Bull*., No. 652) Humboldt City, Nevada. Microscopic crystals of scheelite occur in contact-metamorphic deposits. Cassiterite and tourmaline are absent.

In Humboldt County and near Montgomery, Mineral County, Nevada (F. L. Hess, "Tungsten Minerals and Deposits," *U.S. Geol. Surv. Bull*., No. 652). Scheelite occurs in contact-metamorphic deposits. Cassiterite and tourmaline are absent.

In the Grouse Creek Range, Box Elder County, 15 miles north of Lucin, Tooele City, Utah (F. L. Hess, "Tungsten Minerals and Deposits," *U.S. Geol. Surv. Bull*., No. 652). Scheelite occurs in contact-metamorphic deposits. Cassiterite and tourmaline are absent.

In Deep Creek Mountains, Tooele City, Utah (F. L. Hess, "Tungsten Minerals and Deposits," *U.S. Geol. Surv. Bull*., No. 652). Scheelite occurs in contact-metamorphic deposits. Cassiterite and tourmaline are absent.

West and South of Bishop, Inyp County, California (J. J. Runner and M. L. Hartmann, "The Occurrence, Chemistry, etc., of Tungsten," Rapid City, S. Dakota, Sept. 1918). Here various sediments are inclosed in granite. The principal ore-bodies follow the bedding of the inclosed sedimentary strata, and the following minerals are present—scheelite, garnet, epidote, quartz, calcite, hornblende, pyroxenes, etc.

In Apache No. 2 Mining District, 6 miles S.S.E. of Hachita, N. Mexico (F. L. Hess, "Tungsten Minerals and Deposits," *U.S. Geol. Surv. Bull*., No. 652). Scheelite occurs in contact metamorphic deposits. Cassiterite and tourmaline are absent.

Near Weldon, Kern County, California (F. L. Hess, "Tungsten Minerals and Deposits," *U.S. Geol. Surv. Bull*., No. 652). Scheelite occurs in contact-metamorphic deposits. Cassiterite and tourmaline are absent.

At Cape Mountain, near Cape Prince of Wales, Alaska (Adolph Knopf, "Geology of Seward Peninsula Tin Deposits," *U.S. Geol. Surv. Bull*., No. 358, 1908). Scheelite is found in microscopic particles in contact-metamorphosed limestone. Cassiterite and tourmaline are absent.

On the Suan Concession, Korea (F. L. Hess, "Tungsten Minerals and Deposits," *U.S. Geol. Surv. Bull.*, No. 652). Scheelite occurs in metamorphosed sedimentaries which are worked for gold. Cassiterite and tourmaline appear to be absent.

Pegmatoid Deposits. The following come under this classification:

In several mines in the Federated Malay States and in Siam (J. H. Collins, "Observations on the West of England Mining Region," 1912, p. 16; and several other authorities). Cassiterite occurs without tungsten minerals in pegmatite veins in parts of the Malay States and in Western Siam. Wolframite and scheelite occur in association with cassiterite in a few pegmatite veins intrusive in metamorphosed sedimentaries, including limestone in Malaya. Tourmaline is very plentiful in most of the veins in Malaya, and in those of Siam.

At Maliwun, southernmost part of Burma. The concentrates carry from 2% to 5% of wolfram, the rest being cassiterite. A little tourmaline occurs, and sulphides are plentiful.

In Cornwall (J. H. Collins, "Observations on the West of England Mining Region," 1912, p. 16; also several other authorities). The bulk of the tin deposits are in pegmatoid veins intrusive in granite and in metamorphosed sedimentary rocks (killas) near the granite contact. Tourmaline is plentiful. Wolframite, in general, gives place in depth to tin deposits. Copper minerals are higher up the fissures than the tin deposits, and zinc and lead minerals are still higher up and further *from* the granite.

Near Oreville and Hill City, S. Dakota (F. L. Hess, "Tungsten Minerals and Deposits," *U.S. Geol. Surv. Bull.*, No. 652, p. 38). Wolfram occurs in pegmatite veins.

At Blue Grouse Mountain, near Loon Lake, Stevens County, Washington (F. L. Hess, "Tungsten Minerals and Deposits." *U.S. Geol. Surv. Bull.*, No. 652, p. 38). Wolframite occurs in a fine-grained pegmatite.

At Etta Knob in Black Hills of Dakota (R. H. Rastall, "The Genesis of Tungsten Ores," *Geol. Mag.*, 1918, p. 197). Cassiterite, wolframite, molybdenite, arsenopyrite, tantalite, columbite, apatite, beryl, and spodumene occur in a vertical pipe of pegmatite.

In Lincoln, Gaston and Cleveland Counties, N. and South Carolina (F. L. Hess and L. C. Graton, "The Occurrence and Distribution of Tin," *U.S. Geol. Surv. Bull.*, No. 260, p. 163). Cassiterite occurs in pegmatite veins.

At El Porvenir, El Porvenir District, N. Mexico (F. L. Hess, "Tungsten Minerals and Deposits." *U.S. Geol. Surv. Bull.*, No. 652, p. 38). Scheelite occurs with quartz, felspar, fluorspar, molybdenite, and copper minerals in pegmatite.

On the north side of Tunk Pond, near Cherryfield, Maine (F. L. Hess, "Tungsten Minerals and Deposits," *U.S. Geol. Surv. Bull.*, No. 652, p. 38). Scheelite occurs in pegmatite veins. Cassiterite and tourmaline appear to be absent.

Near Rinconda, Rio Arriba County, N. Mexico (F. L. Hess "Tungsten Minerals and Deposits," *U.S. Geol. Surv. Bull.*, No. 652, p. 38). Wolfram, tourmaline, quartz, and copper minerals occur in pegmatite veins.

At Ivigtut, Greenland (R. H. Rastall, "The Genesis of Tungsten Deposits," *Geol. Mag.*, 1918, p. 198). Ferberite is found in pegmatite with abundance of cryolite, the ferberite carrying nearly 1% of the oxides of columbium and tantalum. In the central mass cryolite predominates, with blende, galena, chalcopyrite, etc. The marginal portions are pegmatitic in character and contain quartz, felspar, wolframite, cassiterite, molybdenite, and columbite.

At Torrington, New South Wales (J. E. Carne, "The Tungsten Mining Industry of New South Wales," *N.S.W. Geol. Surv., Min. Res.* 15, 1912). Wolframite and bismuth occur in pegmatite veins.

At Mount Carbine, Queensland (Lionel C. Ball, *Geol. Surv. of Queensland*, Pub. No. 251). Wolframite and a little scheelite occur in pegmatite veins intrusive in the schist series. The wolframite occurs in the quartz and in the orthoclase felspar. Muscovite, tourmaline, beryl, pyrite, molybdenite, cassiterite, and arsenopyrite occur.

In the Herberton District, Queensland (Lionel C. Ball, *Geol. Surv. of Queensland*, Pub. No. 251). The pegmatite veins are intrusive in highly metamorphosed sediments. Cassiterite, wolfram, bismuthinite, antimonite, chalcopyrite, galena, magnetite, tourmaline, topaz, and fluorspar are in association.

At Bamford, Queensland. Some of these deposits are in pegmatites and greisens. Wolframite, bismuth, bismuthinite, molybdenite, pyrites, chalcopyrite, blende, galena, cassiterite (rare), and other rare minerals occur.

Mount Bischoff, Tasmania (R. H. Rastall, "The Genesis of Tungsten Ores," *Geol. Mag.*, 1918, p. 200). Cassiterite, wolfram, arsenopyrite, pyrrhotite, tourmaline, topaz, and fluorspar occur in pegmatite veins, the topaz being very plentiful.

Nigeria (J. D. Falconer, "Nigerian Tin; its Occurrence and Origin," *Econ. Geol.*, vol. 7, p. 545). At Eri, in Kabba province, cassiterite and muscovite occur in pegmatite veins in gneiss. Some of the tourmaline pegmatites do not carry cassiterite, but it is now known that others do. Topaz is plentiful with the alluvial tin, and will probably be found in the lodes.

Mexico (F. L. Hess and L. C. Graton, "The Occurrence and Distribution of Tin," *U.S. Geol. Surv. Bull.*, No. 260, p. 180). The cassiterite occurs in rhyolite, associated with fine-grained granite, and sometimes with thin-bedded Cretaceous shales and limestones. The accompanying minerals are quartz, topaz, biotite, hematite, and chalcedony.

Bolivia (F. L. Hess and L. C. Graton, "The Occurrence and Distribution of Tin," *U.S. Geol. Surv. Bull.*, No. 260, p. 174). Cassiterite occurs in quartz-porphyry, and in rhyolite in both sedimentary and igneous rocks; the veins appear to be replaced in depth by sulphides, chiefly iron pyrites. Stannite is present. Tourmaline, fluorite, wolframite, arsenopyrite, chalcopyrite and other sulphides occur.

In the Erzgebirge fields in Saxony and Bohemia (J. T. Singewald, Jr., "The Erzegebirge Tin Deposits," *Econ. Geol.*, vol. v, 1910). At Altenberg; cassiterite occurs in a stockwork in quartz-porphyry associated with bismuth. At Zinnwald; wolframite, scheelite, cassiterite, arsenopyrite, galena, blende, chalcopyrite, tourmaline, topaz, and apatite occur. The wolframite appears to occur in greater abundance with the sulphides. At Graupen; the tin-lodes pass gradually in pyrite veins. Dalmer believes that the zinc-blende and galena deposits are also connected with the granitic intrusion but at a zone more remote from the intrusion than are the tin deposits. At Ehrenfriedersdorf; like the deposits of Zinnwald. At Geyer; cassiterite occurs as a zwitter. Topaz is abundant, tourmaline is present, and wolframite occurs only in subordinate amounts.

In Spain (R. H. Rastall, "The Genesis of Tungsten Ores," *Geol. Mag.*, 1918, p. 197). In the mountain chains of Central Spain, in the province of Toledo, at Mijas near Málago, and in the Almagara Mountains, the wolfram is associated with cassiterite. Ferberite, free from manganese, occurs at Almagara Mountains.

In the province of Salamanca cassiterite occurs in veins, mostly quartz veins, with tourmaline and wolframite. (Amalido Gil y Maestre, "Description, fisicia, geológica y minera de la Provincia de Salamanca." *Men. Com. Mapa Geol. Espana*, 1880, pp. 255-61). In Portugal; wolfram occurs with cassiterite and arsenopyrite in the Sierra de Estrella mines. Granell (Granell, *Bol. Soc. Esp. Hist. Nat.*, vol. ix, 1909, p. 81) states that wolframite-cassiterite deposits extend from Galicia through northern Portugal, Zamora, Salamanca, and Caceres as far as the Guadalquivir fault.

In Brittany (R. H. Rastall, "The Genesis of Tungsten Ores," *Geol. Mag.*, vol. v, 1918, p. 196). Wolfram, cassiterite, molybdenite, mispickel, chalcopyrite, blende, and fluorspar occur in a stockwork, which is pegmatitic.

Quartz Vein Deposits. The following come under this classification:

At Tavoy and Mergui Districts, Burma (W. R. Jones, "The Origin of Wolfram, etc.," *Lecture, Govt. Advis. Bd., Tavoy, Burma*, Sept., 1917; J. Coggin Brown, "The Geology of Tavoy District," *Lect., Govt. Advis. Bd., Tavoy, Burma*, 1917; J. Morrow Campbell, "The Ore Mineral Deposits of the Tavoy District," *Lect. Govt. Advis. Bd., Tavoy, Burma*, June, 1918). Almost all the wolframite and cassiterite obtained from these two districts, amounting for Tavoy District alone to 3,653 tons of concentrates in 1917, were derived originally from quartz veins. A few of the veins in Mergui District grade from pegmatite into quartz veins, but the great majority in Mergui, and almost all the veins in the Tavoy District, are free from felspar. (The pegmatite veins of Pagaye Mine, Tavoy, are notable exceptions). Tourmaline is rare in Tavoy and more common in Mergui District. Cassiterite occurs in intimate association with wolframite, the proportion of cassiterite to wolframite being in general higher in Mergui than in Tavoy. Sulphides are common in both places.

At Thaton, near Moulmein, Burma. The lodes are pegmatitic in parts, and tourmaline is fairly common. Cassiterite is rare in the wolframite lodes.

At Yamethin (Byingyi) north of Rangoon, Burma (J, Coggin Brown and A. M. Heron, "The Distribution of Ores of Tungsten and Tin in Burma," *Rec. Geol. Surv., India*, vol. Z, part 2, 1919, pp. 102-121). Molybdenite and beryl are common. Cassiterite is rare.

At Mawchi, Upper Burma. Cassiterite and wolframite occur in quartz veins in granite. Tourmaline and sulphides are present.

At the following wolfram fields in China (these were examined by the author in 1919). The Kowloon Deposits, near Hong-Kong. Wolframite occurs in quartz veins in granite and in occasional patches of schists and phyllites. The concentrates carry small percentages of tin, generally under 1%. Pyrites and arsenopyrite are present in the least weathered parts of the lodes. Tourmaline is absent. The Pingshan deposits, east of Waichow, Kwantung. Wolfram occurs in stockworks of small quartz veins in schists and phyllites, and in granite. The concentrates carry on an average about 0·5% of tin. Tourmaline is absent, and pyrites is sparingly present in the weathered outcrops. The San To Chuk deposits, north-east of Waichow, Kwantung. These are similar to the Pingshan deposits. The Kuku Mines, east of Shiuchow, Kwantung. Wolframite and bismuth occur in quartz veins in granite, which is capped by schists and phyllites. The percentage of bismuth is higher in the lodes outcropping on the flanks of the ridges than in the lodes nearer the top of the mountains, and in the former it makes up from 40% to 50% of the concentrates. A few flakes of molybdenite occur. The concentrates carry under 1% of tin, and tourmaline is absent. The Yukongshien deposits, south-west of Ichang, Hunan. Wolframite occurs in very wide quartz-veins intrusive in granite, schists and quartzites. Arsenopyrite is very abundant in some of the veins, and these were formerly worked for arsenic, the wolframite being discarded in the dumps. Cassiterite is rare, and tourmaline absent. The Gong-Hong deposits, Kwantung. Wolframite occurs in stockworks of quartz in schists, phyllites, and granite. White mica is particularly abundant, and bismuth is recovered in the concentrates. Cassiterite is rare; tourmaline is absent. Pyrites and a little arsenopyrite occur. The Tin Nam deposits, south of Kiangsi, near the Kwantung Boundary. Wolframite occurs in a series of quartz veins intrusive into metamorphosed sedimentaries, chiefly phyllites. The abundance of white mica is a feature of these deposits. Pyrites occurs. The concentrates carry under 0·5% of tin, and tourmaline is absent.

The Wolfram Mines of Kedah, north of the Federated Malay States. Wolframite and cassiterite occur in very wide quartz veins in schists, phyllites, and quartzites. The veins are slightly felspathic in parts. A little tourmaline occurs, and pyrites and arsenopyrite are present in the least weathered parts of the lodes.

The Titi deposits, Negri Sembilan, Federated Malay States. Wolframite and cassiterite occur in quartz veins in schists, phyllites, and granite. A few sporadic crystals of felspar occur in the quartz veins. Tourmaline and topaz are present sparingly, and sulphides occur.

The Tikus deposits, Billiton, Dutch East Indies. The Tikus Mine is the only place where wolfram is worked in Billiton. Cassiterite and wolframite occur in a quartzite pipe. Topaz is plentiful, some tourmaline is present, and arsenopyrite, pyrites, blende, and galena are plentiful. The blende and galena appear to have been formed later than the cassiterite and wolframite.

In several mines in the F.M. States and in Siam (Report on the Siamese Wolfram Fields by Stanley Clay). A good deal of the cassiterite occurring in detrital and alluvial deposits is derived from quartz veins intrusive in granite, mica-schists, and in limestone (W. R. Jones, "Mineralization in Malaya," *Mining Mag.*, Oct., 1915). Pegmatite veins frequently grade into quartz veins, which continue to carry cassiterite and tourmaline after the felspar content has disappeared.

At Hill City, S. Dakota (J. J. Runner and M. L. Hartmann, "The Occurrence, etc., of Tungsten," Rapid City, South Dakota, Sept. 1918). Tungsten minerals occur with cassiterite, apatite, mica, and a little felspar. Wolframite is in the quartz-rich portions of the veins, and cassiterite is more common in the more pegmatitic parts.

On Irish Creek, Rockbridge County, Va. (F. L. Hess and L. C. Graton, "The Occurrence and Distribution of Tin," *U.S. Geol. Surv. Bull.*, No. 260, p. 163). Wolframite and cassiterite occur with arsenopyrite, pyrites, beryl, and muscovite in narrow quartz veins cutting a coarse granite.

At Pony, Montana. Hubnerite occurs in a quartz vein that grades into pegmatite.

At Leadville, Colorado. Gold-bearing quartz-pyrite veins occur containing wolfram and a little scheelite.

At Cassiterite Creek, Seward Peninsula, Alaska. Cassiterite and wolfram occur as veins and stringers in a quartz-porphyry which is intrusive in limestone. Arsenopyrite, pyrites, blende, galena, molybdenite, fluorite, topaz, and zinnwaldite are present.

At Hodgkinson, Queensland. Wolfram and molybdenite occur in quartz veins.

At Bamford, Queensland. Some of the wolfram deposits are mainly in the form of pipes of white quartz. Molybdenite, bismuth, and fluorides are present.

At Oruro and Potosi, Bolivia. These interesting deposits are in association with laccolithic intrusions of rhyolites and dacites. The gangue is quartz, barite, and carbonates. The sulphides of iron, lead, zinc, copper, antimony, bismuth, and silver are present. Fluorspar and tourmaline are rare. A little stannite occurs, and also wood-tin which is probably secondary after stannite.

At Durango, Guanajuato, San Luis Potosi, Mexico (R. H. Rastall, "The Genesis of Tungsten Ores," *Geol. Mag.*, 1918, p. 201). The cassiterite-wolfram deposits are associated with rhyolites. Bismuth, hematite, and topaz are present. No tourmaline and no sulphides occur.

In Salamanca and Zamora, Spain (F. L. Hess and L. C. Graton, "The Occurrence and Distribution of Tin," *U.S. Geol. Surv. Bull.*, No. 260, p. 177). Cassiterite occurs in quartz veins in granite and mica-schist. Much tourmaline and some fluorite, apatite, white mica, molybdenite, chalcopyrite, and galena are present.

Replacement Deposits. The following come under this classification :

At Lead and Northern Hill, South Dakota (J. J. Runner and M. L. Hartmann, "The Occurrence, Chemistry, Metallurgy and Uses of Tungsten," Rapid City, South Dakota, Sept. 1918). Wolframite and small quantities of scheelite, gold, silver, pyrites, etc., have replaced parts of a bed of dolomite. Many fragments of shells of Cambrian age are preserved in the ore.

At Cave Creek, Arizona (F. L. Hess, "Tungsten Minerals and Deposits," *U.S. Geol. Survey Bull.*, No. 652, p. 41). A micaceous phase of a granite has been in part replaced by cuprotungstite and ferberite, the latter occurring in rounded blobs.

Near Fairbanks, Alaska (Alan M. Bateman, "A Tungsten Deposit near Fairbanks, Alaska," *Econ. Geol.*, vol. xiii, March 1918, p. 112). The Stepovitch deposit occurs in schists in the immediate vicinity of porphyritic granite. It appears to be a replacement and impregnation of limestone along its contact with the mica-schist, for, although it resembles a contact-metamorphic deposit, it is not a typical one. The scheelite is finely disseminated through the limestone.

At Longhill, near Trumbull, Conn. (W. H. Hobbs, "The Old Tungsten Mine at Trumbull, Conn," *U.S. Geol. Surv. 22nd Ann. Rep.*, pt. 2, p. 16, 1901 ; F. L. Hess, "Tungsten Minerals and Deposits," *U.S. Geol. Surv. Bull.*, No. 652, p. 41). A metamorphosed limestone, lying between gneisses, carries scheelite, quartz, zoisite, epidote, and other minerals. Pegmatite and quartz veins are intrusive into the rock and it appears doubtful whether this is a true replacement or a contact-metamorphic deposit.

At Campiglia Marittima, Tuscany, Italy (A. Bergeat, "Beitrage zur Kentniss der Erzlagerstatten von Campiglia Marittima," *Neue Jahrb.* 1901, I, pp. 135-156). Cassiterite occurs with limestone as replacement deposit in limestone. The usual fluorides associated with cassiterite are absent. This may be a contact-metamorphic deposit.

Can Amalgamation be Dispensed With ?—At the February meeting of the Chemical, Metallurgical, & Mining Society of South Africa, Eustace M. Weston read a paper entitled : "Can Amalgamation be dispensed with ?" He is in favour of abandoning amalgamating plates and substituting tables with removable riffles and having porous bottoms through which air is forced for the purpose of keeping the sand and pyrite lively. One type of apparatus he describes as follows : The apparatus would have approximately the same width as the present amalgamating tables. Preferably it should increase in width at the lower end. The length would not need to be greater and would probably be less than present tables, and the slope would be probably 12°. The top portion of the table would be about 12 in. long and divided into two or three compartments longitudinally to allow of control of the water supply. There would be three castings having a surface of 2 ft. by 1 ft. each. These would be covered with a tightly-fitting bronze cover about 1 in. thick. This would be pierced with a series of holes about $\frac{1}{12}$ in. diameter, spaced 2 in. apart across the table, in rows 1 in. apart down the table. These holes would be staggered in alternate rows. On the surface of the table each hole would be expanded into a cup-like depression, about 1 in. in diameter and about $\frac{1}{4}$ in. deep. Water under pressure would be supplied to each section of the table, converting the holes into so many hydraulic sorting columns, ending in areas of "boiling sand" at the table surface. The pressure would be regulated to give the grade of concentrate required. The draw-off cocks at the foot of the table would be of special construction and securely locked. The remainder of the table would have a corrugated surface with corrugations having a width of about $1\frac{1}{2}$ in., but of about half the height. Over the troughs of these corrugations are to be arranged small tubes having a bore of about $\frac{1}{10}$ in. with two lateral deliveries. These tubes would be fed with water or air under slight pressure from pipes, or portable trays arranged in such a way as to be removable, but, when in place, to render access to the plate impossible. These pipes would be arranged about 1 in. to $1\frac{1}{2}$ in. apart and staggered in alternate rows. They would keep the sand and concentrate in the troughs "lively" and present an ideal settling surface for the gold particles. It might be found advisable to draw off the bulk of the coarse gold at once as soon as it leaves the tube-mill by inserting in the launder a small spitzluten with a long sorting column of quarter-inch pipe, or less, and with a strong rising column, and to deliver the concentrate direct to a locked receptacle.

This paper will give rise to much discussion. For instance, it is pointed out that the injection of air will have the effect of causing much gold to float, according to the principles of froth-flotation.

Amalgamation at New Goch.—Another paper on amalgamation read before the February meeting of the Chemical, Metallurgical, & Mining Society of South Africa was by H. J. Lee, who described the present practice of gold recovery at the New Goch mine. In order to reduce the loss in mercury in treating this low-grade ore, the author removed the amalgamating plates below the stamps and substituted plates covered with corduroy. About 23 sq. ft. of corduroy is used to every 5 stamps. The ratio of water to ore must be increased, to about 7 : 1, or the accumulation of sand will result. The corduroy is washed every twelve hours and renewed every six weeks. The concentrate is amalgamated in a clean-up barrel. Amalgamating plates are still used below the tube-mills, and at the bottom of each plate a strip of corduroy is fixed, which acts as a concentrator and also prevents the loss of mercury. This strip serves incidentally to remove iron and pyritic accumulations from the tube-mill circuit.

Coal Deposits in Iceland.—At the meeting of the Mining Institute of Scotland, held on February 7, H. H. Eiriksson read a paper on the coal deposits of Iceland. Coal of Tertiary formation is found extensively in north-east and west Iceland. Professor T. Thoroddsen, when travelling in Iceland (1882-1898), did much in discovering coals and lignites; but the weathered and half-hidden outcrops did not give a favourable impression of the quality and size of the seams, and nothing was therefore done to investigate the possibilities of working any of these deposits until 1915. Then the owner of one of the best and thickest seams in the west of Iceland, namely, the Stalfjall seam, marked (2) on the map, formed an Icelandic-Danish company to work it. The company has been in operation since 1916, but has always worked at a loss. Another seam was also started in 1915 in Tjörnes (3) in the north of Iceland, but was not worked regularly until 1917, when it was taken over by the Icelandic Government. The opening out of these seams, together with the scarcity of fuel due to the restrictions placed on coal imports to Iceland by the war, drew attention to several of the other seams. Coal was actually taken from a few of them, but only to a small extent and without any proper appliances, and consequently the coal did not even pay for the labour expended in getting it. Most of the coals in Iceland are lignites, and are all of Tertiary formation. Their actual geological horizon has not yet been finally determined, but they belong most probably to the Oligocene period.

The author describes two of the seams in east Iceland. One of these, the coal-seam in Jökulbotnar (4) on the Reydarfjörd, is 6 ft. 4 in. thick, but of this only about 1 ft. 10 in. is real coal, the rest being either claystone or a mixture of clay-material and coal. The seam lies about 1,000 ft. above sea level. It has been opened out in two places, one on each side of a normal fault along the line of which a stream flows that has worked a kind of hollow or valley in the mountain. The seam has been traced through the greater part of the mountain where it occurs, and also in the headland on the north side of the firth, where it lies a good deal higher, indicating that the inclination is fairly uniform. But debris and clay falling for centuries from the vertical faces of the upper layers of the lavas have nearly everywhere completely covered the outcrop, thus making it difficult to follow or discover it again. The other deposit is in Skalanes (5), in Seydisfjörd. There the coal occurs as lenticular patches, thickest in the centre and thinning out in all directions, the thickness varying from 1 in. to 6 in. The size of the patches might be from a few yards to perhaps half-a-mile in diameter. It is difficult to follow the outcrop, as it occurs in a precipice, about 45 ft. above sea level, on the top of a basalt sheet which protrudes just sufficiently to allow a man to walk along it. The deposit forms part of the parting between two basalt sheets, the top and bottom of the thickest coal being considerably burnt, but the centre portion is very lustrous, and in appearance is similar to ordinary bituminous coal. The thinner patches are usually burnt quite through. The cracks and joints in the coal are nearly completely filled with lime and iron oxide, which have evidently been deposited by waters percolating long after the formation of the coal. These mineral deposits decrease the value of the coal, and increase considerably the percentage of ash and the specific gravity. Analyses show clearly that none of the Icelandic coals is of much commercial value.

Mawchi Tin-Wolfram Mine.—In discussing Dr. W. R. Jones's paper on the tin and wolfram deposits of Burma, read before the March meeting of the Institution of Mining and Metallurgy, E. W. Byrde expressed dissent from the author's statement that

MAP OF ICELAND, SHOWING POSITION OF COAL DEPOSITS.

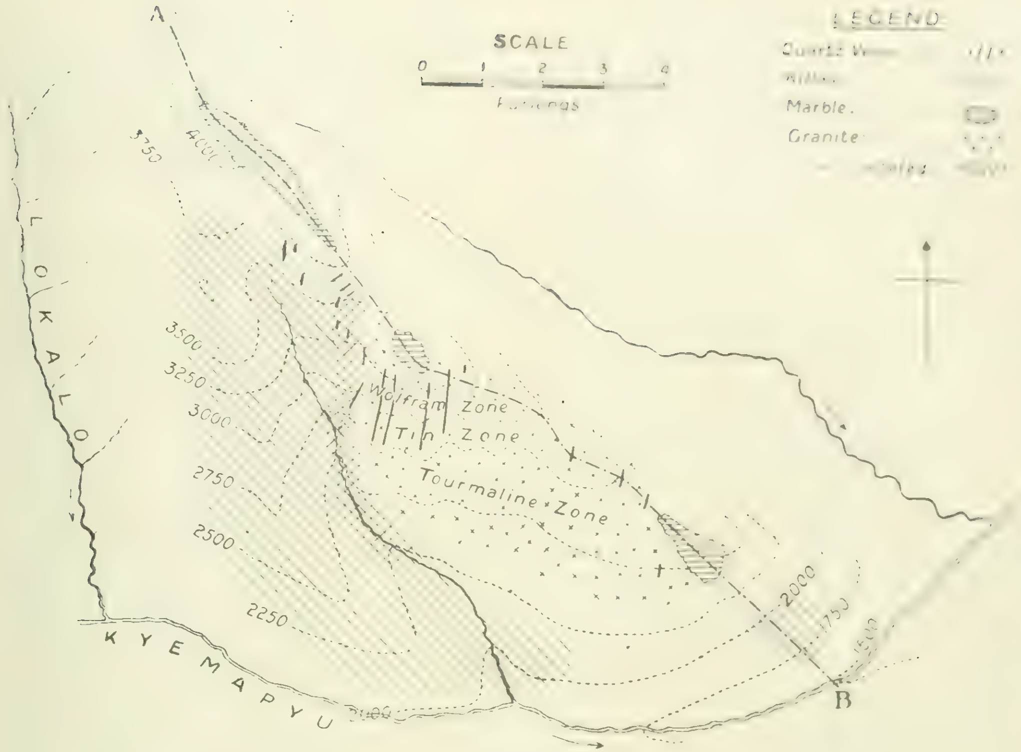


FIG. 1. GEOLOGICAL PLAN OF MAWCHI TIN-WOLFRAM DEPOSITS.

tourmaline is absent, and he produced evidence that in the Mawchi mine, in the Southern Shan States, the proportion of tourmaline in the granite increases in depth as the tungsten decreased and tin increased, and the coarser tourmaline appears almost as a "farewell rock" for the tin. At Mawchi the denudation has been comparatively small. The geological plan in Fig. 1 shows a number of vertical quartz veins, with strike 10° E. of N., outcropping on the south slope of a soft decomposed tourmaline-granite ridge A B running N.W. and S.E. The granite is in places capped by limestone altered to marble and flanked by killas. The latter appear to be baked shales and marls, but with them are included probably hidden dykes. The predominating zones of tungsten, tin, and tourmaline are shown for the group of veins in the granite under the middle limestone cap. The quartz outcrops in the granite were hard and massive in depth, but got softer and veinous towards the limestone cap. There were quartz outcrops in the killas also, but these crumbled to one's touch and had evidently been full of sulphides and had lost the finer wolfram in solution, thus giving an artificially high tin content. The weathered killas, too, was very rotten, covering the slope in depth with earth reddened by iron and decomposed wolfram. West of these outcrops in killas the altitude increases and there is no further granite visible. It is of interest to note that the stream draining this high valley is called "Lokalo," or "Wolfram stream." Loka is a Karen word of opprobrium for any heavy stone such as wolfram or magnetite that on smelting fails to produce tin. The Kyemapyu, on the other hand, the river that drains the district, means the "tin" river.

Fig. 2 shows the section A B along the apex of the ridge running N.W. and S.E. Fig. 3, showing a longitudinal section along the quartz outcrop, is typical of the strongest exposed veins, which are elongated lenses in plan, truncated at $\frac{3}{5}$ths maximum width at the top nearest the limestone, with evidence of the strike turning westward and splitting up into veinlets, while down the slope they thinned out as far as they were followed to $\frac{1}{10}$th maximum width. Generally speaking the total tin and tungsten contents increased with width. Whether they were true lenses or whether the width was directly proportional to the distance from the point of contact with the overlying sedimentaries before denudation, or whether the width was inversely proportional to the thickness of the latter at the time of formation, only development on these and the killas veins could throw light.

The following is an account of the vein farthest from altered rocks :

Altitude 3,600 ft.	Top of marble crag ; no vein.
.. 3,500 ft.	Base of overhanging crag ; natural cave enlarged by Karens ; no vein or mineral seen ; red earth.
.. 3,450 ft.	Gully half filled with debris, made by Karen sluicing, is between granite walls and follows the direction of vein ; parallel veinlet in wall is visible.
,, 3,400 ft.	Vein $\frac{1}{2}$ maximum width, containing wolfram, cassiterite, and

scheelite, wolfram predominating.

Altitude	3,300 ft.	$\frac{2}{3}$ maximum width; ditto, richer and more massive.
,,	3,200 ft.	Maximum width; massive wolfram in parallel veins in the quartz vein.
,,	3,100 ft.	Maximum width; wolfram contents much lessened.
,,	3,000 ft.	$\frac{2}{3}$ maximum width; cassiterite predominating; no scheelite.
,,	2,900 ft.	$\frac{1}{3}$ maximum width; nearly all cassiterite.
,,	2,700 ft.	$\frac{1}{10}$ maximum width; cassiterite only.

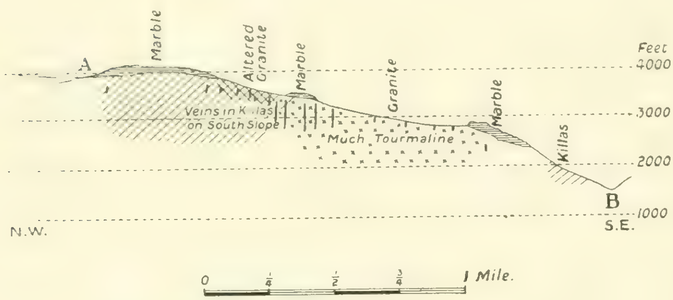


FIG. 2. SECTION ALONG APEX OF RIDGE A.B.

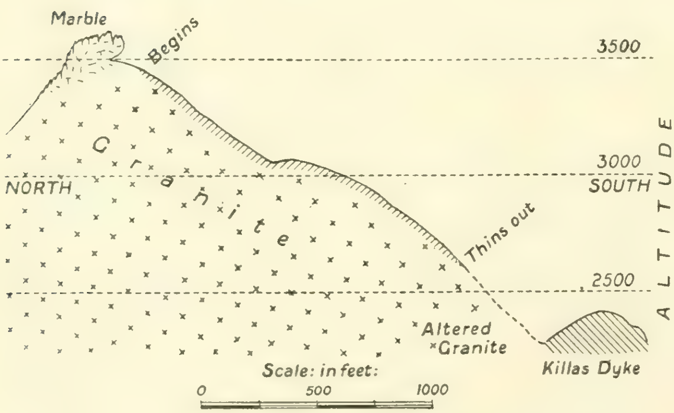


FIG. 3. SECTION ALONG QUARTZ OUTCROP.

Tourmaline was present throughout in the granite but increasing in depth. The cassiterite was resinous in colour, and occurred in bunches or in separate crystals embedded in the quartz; there was nearly always some in limpet-like contact with the wolfram, even when the latter was veinous. The scheelite appeared to be a secondary product resulting from the contact of descending acidified solution of the limestone with the wolfram. Pyrites occurred in small quantities throughout.

The following are particulars of a vein on the side nearest to altered rocks:

Altitude	3,600 ft.	No marble cap.
,,	3,500 ft.	Clay face, sluiced by Karens.
,,	3,450 ft.	Strong outcrop starts suddenly.
,,	3,400 ft.	Strong outcrop and a parallel vein of magnetite noted.
Altitude	3,300 ft.	Vein wider and walls contain mineral also.
,,	3,200 ft.	Ditto; much arsenical pyrites.
,,	3,100 ft.	Maximum width; large cubes of galena showing; little wolfram.
,,	3,100–2,800 ft.	Precipitous; not followed.
,,	2,800 ft.	Quartz tourmaline vein containing no trace of tin; meets vein of manganesic felspar breccia.

SHORT NOTICES.

Conveying Men Underground.—The *Iron & Coal Trades Review* for April 23 reprints an illustrated paper by S. Field, read at the Midland branch of the National Association of Colliery Managers, describing plant used in conveying men underground at the Newstead colliery, Nottingham.

Oil Drilling.—At the May meeting of the Institution of Petroleum Technologists, R. Stirling read a paper on the air-lift as applied to oil drilling and described recent improvements in the apparatus.

A Big Gold Dredge. — In the *Engineering and Mining Journal* for May 15, H. G. Peake describes the Eastabrook Company's gold dredge, to operate in California. It has buckets of 20 cu. ft. capacity.

Flotation at Ray Consolidated.—In the *Engineering and Mining Journal* for April 10, H. C. Mc.-Crae describes the porous concrete bottoms used in the flotation cells employed at Ray Consolidated.

Dorr Thickeners.—In the *Engineering and Mining Journal* for April 10, Henry Hanson writes on recent improvements of the Dorr thickener. The same issue contains a personal appreciation of Mr. Dorr and his work.

Metallurgy at Broken Hill.—At the May meeting of the Institution of Mining and Metallurgy, Gilbert Rigg read a paper on recent improvements in the sintering and smelting of lead concentrates produced at Broken Hill.

Action of Sulphuric Acid on Iron.—The *Journal* of the Society of Chemical Industry for May 31 contains a paper on the action of sulphuric acid on iron, in connection with plant used in handling corrosive liquids.

Cottrell Precipitation.—In the *Mining and Scientific Press* for February 14, Ritaro Hirota and Kyoshi Shiga describe installations of the Cottrell electrostatic precipitation plant in Japanese metallurgical works.

Estimation of Tungsten.—In the *Chemical Trade Journal* for May 15, R. F. Heath gives a method of estimating tungsten.

Zirconium Minerals.—At the April meeting of the Ceramic Society, H. V. Thompson read a paper on the analysis of zirconium minerals.

Leaching Copper Tailing.—In the *Engineering and Mining Journal* for April 10, W. L. Maxson describes the work done at the Shannon copper mine, Arizona, in giving tailing a sulphatizing roast.

Blast-Furnace Practice.—At the May meeting of the

Iron & Steel Institute, F. Clements read a paper on recent practice in blast-furnace work in iron metallurgy.

Manganese in Montana.—*Chemical and Metallurgical Engineering* for April 14 contains a paper by E. S. Bardswell describing the experimental electric smelting of manganese ores at the works of the Anaconda Copper Company.

New Zealand Iron Sands.—At the May meeting of the Iron & Steel Institute, J. A. Heskett read a paper on the titaniferous iron ores at Taranaki, New Zealand, and the results of smelting.

Laterite.—The *Geological Magazine* for May contains a paper by F. Dixey on lateritization in Sierra Leone.

Mexican Ore Deposits.—In the *Mining and Scientific Press* for March 20, S. J. Lewis commences an article on the ore deposits of Mexico.

Chrome Ore in Carolina.—In the *Engineering and Mining Journal* for May 15, J. Volney Lewis writes on the chrome ores of Carolina, which do not give great promise of commercial value.

Dolly Varden.—In the *Mining and Scientific Press* for May 1, A. J. T. Taylor gives an account of the Dolly Varden silver mine and its vicissitudes.

Colloil.—*Engineering* for May 1 describes a liquid fuel called "colloil," consisting of oil in which fine coal or coke is suspended, the invention of G. C. Calvert, of Twickenham.

British Empire Oil.—On June 4, Sir John Cadman read a paper before the Royal Society of Arts on the oil resources of the British Empire.

The Tin Supply.—The *Engineering and Mining Journal* for May 1 publishes a paper by James M. Hill on the political and commercial control of tin.

Arkansas Diamonds.—In the *Engineering and Mining Journal* for April 24, S. W. Reyburn and S. H. Zimmerman describe the testing work about to be started at the diamond deposits, Arkansas.

Chilean Nitrate.—In *Economic Geology* for May, W. L. Whitehead describes the Chilean nitrate deposits, with an account of their geology and speculations as to origin. He argues in favour of a volcanic origin. The paper contains a useful bibliography.

Engineering in F.M.S.—*The Engineer* for April 30 describes various works undertaken by the Federated Malay States railways, including improvements in ports, railways, and roads.

RECENT PATENTS PUBLISHED.

☞ *A copy of the specification of any of the patents mentioned in this column can be obtained by sending 1s. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C.2., with a note of the number and year of the patent.*

1,466 of 1918 (119,647). SOCIÉTÉ INDUSTRIELLE DE PRODUITS CHIMIQUES, Paris. Modifications in the process for making chromates by the action of sodium or potassium carbonate on chrome ore, having for the object the prevention of the formation of other salts.

16,804 of 1918 (120,565). COOPER RESEARCH Co., and H. S. COOPER, Cleveland, Ohio. An alloy consisting of aluminium with varying quantities of beryllium, such an alloy being stronger and lighter than aluminium.

17,650 of 1918 (141,766). C. HEBERLEIN, London. Improvements in the method of electrolytically depositing nickel from nickel sulphate on insoluble anodes.

17,749 of 1918 (142,157). H. MACONOCHIE and D. DE ROS, London. Furnace for the production of tin or zinc oxide by the combustion of the metal.

18,982 of 1918 (141,092). E. W. RILEY, Royal Navy. Method of coating iron and steel with white metal.

20,912 of 1918 (142,161). J. ADAIR, Alcombe, Somerset. Method of drying china-clay.

365 of 1919 (129,829). ARMOUR FERTILIZER WORKS and M. SHOELD, Chicago. Process and electric furnace for producing aluminium nitride from carbon and bauxite in an atmosphere of nitrogen

374 of 1919 (141,122). G. H. WORRALL, Kirkwood, Missouri. Hardening lead by the admixture of small amounts of barium, calcium, and mercury

693 of 1919 (141,783). G. A. PERCIVAL and EDISON-SWAN ELECTRIC CO., LTD., London. A continuous process for extracting argon from the air cheaply.

5,037 of 1919 (141,466). M. CAZALET, London. A surveying instrument for measuring slopes of earth.

6,392 of 1919 (142,246). and 24,166 of 1919 (142,389). F. G. GASCHE, Chicago. Pneumatic method of concentrating ore.

10,150 of 1919 (141,908). GENERAL ELECTRIC Co., Schenectady, New York. Improved method of producing liquid halogen compounds of silicon, boron, and titanium.

10,604 of 1919 (127,243). SOCIÉTÉ ANONYME DE COMMENTRY - FOURCHAMBAULT ET DECAZEVILLE, Paris. An alloy that will stand great cold, such as is experienced in machinery for liquifying air, consisting of nickel and iron with small proportions of other metals; a characteristic example is nickel 55%, iron 43%, manganese 2%.

11,725 of 1919 (142,310). A. MCKECHNIE, Birmingham. Separating nickel from copper in scrap alloy by heating in a reverberatory furnace, thereby removing the nickel as oxide.

11,793 of 1919 (141,925). H. LANGWELL, Stockton-on-Tees. Method of producing finely-divided barium carbonate.

12,372 of 1919 (142,315). H. HARRIS, London, De-zinking lead by adding a mixture of caustic soda and sodium chloride, which converts the zinc to chloride at a comparatively low temperature.

14,889 of 1919 (142,339). R. SUTCLIFFE, Wakefield. Method of supporting the rollers carrying belt conveyors.

15,065 of 1919 (142,342). W. PARKER, Barnsley. Method of suspending and retaining pit cages in case of the breaking of the winding rope.

16,133 of 1919 (141,246) and 29,038 of 1919 (142,048). D. BELAIS, New York. A white gold suitable as a substitute for platinum in jewelry consisting of 75 to 85% gold, 8 to 18% nickel, and 4 to 14% zinc.

16,359 of 1919 (142,354). A. DUCHEMIN, Paris. Improvements in furnaces for making cyanamide.

22,296 of 1919 (132,520). P. DUTOIT and A. BOEVER, Lausanne. In the manufacture of brass, the addition of a salt such as barium chloride which has a specific gravity between the gravities of the slag and the molten metal mixture.

23,431 of 1919 (141,606). F. RIES, New York. Improvements in diamond-polishing machinery.

24,410 of 1919 (141,280). R. IVERSEN, Christiania. A solder for aluminium consisting of 60% tin, 35% zinc, 4% copper, and small portions of aluminium and manganese.

25,316 of 1919 (142,398). H. HARRIS, London. In refining lead, passing it in thin streams through the molten reagent.

26,819 of 1919 (141,290). H. P. SOULIÉ COTTINEAU, Paris. In the precipitation of copper from solutions upon iron, ensuring the production of a high-grade copper by first electrically coating the iron with a thin film of copper.

29,302 of 1919 (135,844). THE DORR CO., and D. S. MCAFEE, New York. In the preparation of iron oxide slime from the cementation vats for the sintering process, drying the slime by adding it to the returns of the sintering machine, thus also quenching the returns.

1,997 of 1920 (138,111). SOCIÉTÉ INDUSTRIELLE DE PRODUITS CHIMIQUES. Paris, Improved method of isolating or purifying alkali chromates.

NEW BOOKS, PAMPHLETS, Etc.

☛ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 723, Salisbury House, London Wall, E.C.2.

Tungsten Ores. By R. H. Rastall and W. H. Wilcockson. Pamphlet, octavo, 80 pages. Price 3s. 6d. net. London: John Murray and the Imperial Institute.

In reviewing such a volume as this it is well perhaps to consider initially the various classes to which it will appeal, and to consider how far it will provide useful information to those who are likely to be attracted by the subject. The reading public for such a volume cannot be very large. It will include those interested in the mining of tungsten ores, those employed in smelting the ores, those using tungsten, ferro-tungsten, and the various tungsten salts, and to some extent metallurgists and students of metallurgy. It may be said at once that all these classes of reader will find many points of interest in the volume, and at the moderate price at which it is published it should be found on the book-shelves of all interested, however remotely, in tungsten and its ores. The printing and make-up are both admirable, and the large scale of the diagrams showing production in various countries makes these specially instructive.

There are three chapters only, dealing respectively with: (*1*) Tungsten ores, their occurrence, characters, and uses; (*2*) Sources of supply of tungsten ores in the British Empire; (*3*) Sources of supply of tungsten ores in foreign countries. The volume is completed by a table of references to 138 published books and papers on the subject.

After reference to the monopoly in manufacture of tungsten enjoyed by Germany before the war and the urgent necessity of supplies by the Allies, tables and charts are given showing the output of tungsten ores from 1910 to 1917. It is unfortunate that the figures for 1918 and 1919 are not included, as the importance of the Chinese production would have been demonstrated.

Attention is drawn to the fact that reserves of tungsten ore are difficult to estimate, owing to the sporadic occurrence of the mineral in lodes and to the fact that the mining of these ores has been mainly in the hands of individuals or small companies, although there has been a tendency for larger capitalists to interest themselves lately. This possibly may be modified in the light of what has occurred during the past year.

A description of the various minerals is given, and reference is made to the much-debated question of the genesis of the mineral relatively to tin ores. Recent papers by Mr. Coggin Brown and Dr. W. R. Jones on the Burma deposits should be read in conjunction with the various papers referred to in the bibliography by those interested in this phase of the subject.

Brief reference is made to the concentration and market value of the concentrates, and a short outline is given of the methods of preparing tungsten metal powder and ferro-tungsten. One point is not made clear, namely, that carbon-reduced tungsten metal powder is not suitable for the preparation of ductile solid tungsten, for which hydrogen-reduced metal of the highest purity is essential.

A comprehensive list is given of the uses of tungsten and ferro-tungsten, but hardly sufficient emphasis is laid on the high percentage of the consumption due to the manufacture of high-speed steel in comparison with which the tonnage utilized for all other purposes is insignificant.

Chapters 2 and 3 need not be reviewed in detail. It will suffice to say that each district from which there is or has been a production of tungsten ores to any considerable extent is dealt with, and the geology, mineralization, production, and general features are considered. The annual production for several years of the more important countries is tabulated, and the relative importance of the different producing areas is thus clearly shown.

The chart and tables of the world's production afford interesting evidence of the wide distribution of tungsten ores in commercial quantities. In 1910 the total world's production was estimated at 7,346 tons, of which the British Empire contributed 2,122 and the United States 1,652 tons, or respectively about 29 and 22½%. In 1917 the total production was estimated at 21,000 tons, of which the British Empire contributed 7,158 tons and the United States 5,000 tons, or 36 and 24% respectively. The figures for 1918 and 1919 probably would modify this comparison materially in favour of the United States. The German output was estimated at from 220 to 250 tons in the war period, but probably in the light of information now obtainable these figures could be modified substantially, and would probably be found to have been considerably underestimated.

There can be little doubt from the evidence collected in this volume that the various sources of supply of tungsten ores can respond to a very large demand, but that the cost of production is likely to rise substantially as the easily worked alluvial or detrital deposits become exhausted. J. L. F. VOGEL.

[The reason for this book being not up-to-date on several points is that nearly eighteen months were allowed to elapse between receipt of the manuscript and the issue of the book; for this delay the author was not to blame.—EDITOR.]

The Mineralogy of the Rarer Metals. By Edward Cahen and William Ord Wootton, with a foreword by F. W. Harbord. Second edition, revised by Edward Cahen. Price 10s. 6d. net. London: Charles Griffin & Co., Ltd.

The first edition of this little book was published in 1913; a second has just appeared. Of the two authors, it is sad to have to record that one—Mr. William Ord Wootton, a young chemist of great promise—died even before the first edition had been issued. The work of revision has consequently been undertaken by Mr. Cahen alone.

As originally published the book was already excellent. In its revised form it is a truly admirable and most useful little volume, which should find a place upon the shelves not only of mineralogists and chemical technologists but also of prospectors, miners, metallurgists, and all others who are interested in the occurrence or future possibilities of the metals dealt with.

These latter are assembled under the collective title of the "rarer metals"—a title which lays itself open to the criticism of the captious, inasmuch as some of the metals included are by no means rare. All are scarce, however, and possibly "scarcer metals" would have better defined the subject matter of the book. Here a word may perhaps be said, in parenthesis, as to the signification of these words "rare" and "scarce" as used in mineralogy. A rare metal may be defined as one that is seldom met with; a scarce metal as one that is never plentiful. A rare metal is not necessarily scarce, nor a scarce one rare. Iron and aluminium are of course neither rare nor scarce. On the other hand nickel is rare but not scarce, gold is scarce but not rare, and platinum is both rare and scarce. Strictly speaking, titanium and zirconium, metals dealt with in this book, should not be included among the rarer metals. They have a practically universal distribution. On the other hand nickel, cobalt, bismuth, and tin, metals not considered in the book, are decidedly rare, and their inclusion might reasonably have been anticipated. But after all, the title chosen serves very well, and leaves little doubt as to the scope of the volume.

Many of the metals considered are at present of scientific interest only; but some of them, as for example lithium, beryllium, cerium, molybdenum, tantalum, platinum, palladium, iridium and osmium, radium, thorium, titanium, tungsten, uranium, vanadium, and zirconium, have economic importance as well. It is from its description of these and of the minerals which contain them that the book derives its principal practical value. Some acquaintance with the other, and for the most part rarer metals, is desirable, however, as pointed out by Mr. Harbord in his prefatory foreword, because "there is always the possibility that if other sources of supply become available, new uses may be found for them and they may suddenly become of considerable commercial value."

After presenting in the early pages some preliminary matters, including a detailed tabular statement of the minerals described, classified on a chemical basis and giving synonyms and varietal names in use for the various species, each of the metals is taken up in turn, its properties, preparation, industrial applications, and chemical detection being first described, and the various minerals in which it occurs being afterwards considered in detail. This, which makes up the major part of the volume, is followed by concluding sections on geographical distribution, on the assaying of the more important metals, and on the systematic blowpipe analysis of minerals in the field. There is a full index.

In a work containing so much matter condensed into such a small space, some errors of type or of fact are bound to creep in, but these are here commendably few. The inclusion of zircon among the oxides raises an old controversial point; if zircon be regarded as an oxide then practically all mineral silicates may with almost equal propriety be so regarded. The reference to zinnwaldite as a variety of lepidolite, and of tantalite as a variety of columbite calls for criticism. Under chemical reactions for the various species the abbreviation B.B. is given as signifying "bunsen burner"; in text-books of mineralogy this usually means "before the blow-pipe." The reactions themselves are not always completely or correctly stated. Amblygonite, for instance, is said to fuse and to give, after ignition on charcoal with cobalt nitrate, a blue colour indicating aluminium; the blue colour, in this case, as in that of all fusible phosphates, borates, or silicates is not an indication of aluminium but of the production of a glass or enamel which necessarily becomes coloured blue by the cobalt. Molybdenum minerals are said to "give green borax or microcosmic beads"; this is true of the latter only. While the localities of occurrence are often given with due precision, they are sometimes so vaguely defined as to make the information of little value. Molybdenite, for example, is described as occurring in "Great Britain; Central Europe, in Saxony and Bohemia; Norway; Sweden; Finland; Greenland; France; Belgium; Spain; Russia." The punctuation also occasionally leaves something to be desired, as in the case of lepidolite which is described as occurring "at Uto, Sweden, Saxony, Urals, Moravia, Hautvienne, France, Elba, Cornwall, Bengal, and throughout the U.S.A." Statistics of production are quoted in tons, but whether long, short, or metric is not stated. These small defects, however, do not seriously detract from the value and usefulness of the book and can easily be remedied in a later edition.

The publishers are to be congratulated upon the mode of presentation of the book, which is bound in flexible leather, and is of suitable size for the pocket. They have also spared neither pains nor expense in the use of a wide range of type for the effective setting out of the matter. In this connection it might perhaps have been better to print the descriptions of the more important minerals, such as monazite, molybdenite, wolfram, scheelite and so forth, in bold type, and of very rare and little-known species is something smaller. This would have indicated in a clear manner the relative importance of the several species.

Commendation, however, and not criticism is what is called for by this handy little volume.

C. G. CULLIS.

Arsenic and Antimony Ores. By Henry Dewey, J. S. Flett, and G. V. Wilson. Vol. 15 of the special reports on the mineral resources of the United Kingdom, prepared by the Geological Survey. Price 3s. net.

Recherches Geologiques et Petrographiques sur le District Minier de Nicolai-Pawda. By L. Duparc and A. Grosset. Geneva: Librairie Kundig; Paris: Dunod et Pinat.

Prospector's Field-Book and Guide. By H. S. Osborn, revised by M. W. Von Bernewitz. Ninth edition. Pocket size, leather, 370 pages, illustrated. Price $3·00. New York: H. C. Baird & Co.

German and English Commercial Correspondence. By N. Sadezky and W. Chevob-Maurice. Paper covers, 130 pages. Price 1s. 9d. net. London: E. Marlborough & Co.

Brazilian Geology. By J. C. Branner. This geological map with 150 pages of explanatory text is published by the Geological Society of America. Price $3·35

Tin Fields of the Federated Malay States. By J. B. Scrivenor. London: Malay States Information Agency, 88, Cannon Street. This album contains a series of photographs demonstrating the methods of working the tin deposits of Malaya. The descriptive notes are written by the F.M.S. Government Geologist.

COMPANY REPORTS

Sons of Gwalia.—This old Westralian gold producer, a member of the Bewick-Moreing group, has been enabled by the gold premium to rejoin the list of dividend-paying mines. In 1919 the quantity of ore treated was 147,652 tons, or slightly less than in the preceding year, but 48,625 oz. gold was obtained, as against 44,721 oz. The gold premium brought in £32,693. The total receipts were £242,343, and current expenditure £190,114, leaving a balance of £52,229, which compares with £12,720 for 1918. Taxes absorbed £18,215, and depreciation £10,009, while the dividend of 1s. per share required £16,250. In 1918 the whole of the working profit, except £71, was absorbed by English and Australian taxes. The general managers state that development work during the past year opened up some profitable lenses of ore, and they refer specially to "the encouraging values met with at the No. 25 level at an inclined depth of 300 ft. below the No. 24 level." The ore reserves at the end of 1919 were estimated to be equal to 3 years and 2 months' supply for the mill, the same as a year earlier, so that although development work last year was curtailed it resulted in the tonnage being fully maintained. E. A. Loring and W. A. Macleod have joined the directorate.

Lonely Reef.—This prosperous Rhodesian gold-mining company nearly doubled its profit last year, thanks partly to the gold premium. The ore milled at 55,420 tons was 1,100 tons more than in 1918, and the average yield was 25·91 dwt. (against 18·24 dwt.). The percentage of recovery was the highest in the history of the mine, the residue being 2·35 dwt. Working costs averaged 49s. 8·8d. per ton milled, as against 42s. 6·9d. in the previous year, the increase being due mainly to the continued high cost of stores, particularly fuel. The total gold extraction was 71,799 oz., which realized £340,016 net, and the net profit was £192,455, against £91,294. Dividends amounting to 50% and a bonus of 25% have been paid, making 75% for the year, as against 25% for 1918. C. B. Kingston, the consulting engineer, in his annual report, dated Rhodesia, February 10 last, gives the development footage for 1919 as 3,355 ft., an increase of 148 ft. on the 1918 total, and his estimate of the ore reserves at the end of December is 199,739 tons, averaging 23·54 dwt. These figures represent an increase of 23,642 tons, but a decline of 0·56 dwt. in value compared with the end of 1918 estimate. He comments that the average grade of the ore in the main ore-shoot is very high, but as the shoot consists of alternating zones of richer and poorer ore the grade of the ore calculated at any particular period is affected by these variations. The rich developments met with in the deep levels call for a further increase in the equipment to carry the work much deeper. Under the deep mining conditions the working cost per ton is unavoidably high, the more so because of the comparatively small tonnage handled. To increase the tonnage mined would necessitate such an increased rate of shaft-sinking and development as is impracticable in a reef yielding a comparatively small tonnage per level. The prospect of the mine having an extended life has made the position of fuel supply of the first importance, and the consulting engineer states that alternative methods of dealing with this question are under consideration. Meantime the contracts for fuel are being extended for the year 1921.

Globe & Phœnix.—The accounts of this Rhodesian gold-mining company show a much smaller profit for 1919 than for the previous year, namely, £132,651 against £178,672. Since the end of December a further sum of £57,452 has been received in respect of the gold premium, which would have made the year's profit £190,103 had it been included in the 1919 accounts. One 20% dividend (1s. per share), free of tax, was paid for the past year, as against 60% for 1918. The ore reserves at December 31 last were calculated at 62,491 tons containing 97,495 oz., and 45,241 tons of ore in pillars containing 78,216 oz., making a total of 108,182 tons containing 175,691 oz. The present financial situation justifies the payment of an interim dividend for 1920 of 1s. 6d. per share, free of tax, which will leave a sufficient balance for the continuance of the development policy. In a report dated March 18, D. P. McDonald states that the limits of the ore-shoots within which previous developments took place proved to have been practically reached, and it became necessary to search for new shoots. The results of the past year's development and prospecting operations were on the whole disappointing.

Crown Mines.—Although this large Rand consolidation has not been able to maintain its annual tonnage at the level of nearly 2½ millions attained in 1915, it has still the distinction among the Witwatersrand mines of crushing the largest quantity of ore, and of being one of the two chief gold producers. Last year the company milled 1,945,000 tons of ore, or about 80,000 more than in 1918. Nevertheless, working costs rose slightly, namely, from 22s. 9d. to 23s. 1d. per ton. Thanks partly to the gold premium, however, the working profit amounted to £750,422 (or 7s. 8d. per ton milled) which compares with £410,642 (4s. 5d. per ton) for 1918, and the net profits were £719,870 and £384,657 respectively. Dividends amounting to 40% were paid for the past year, or double the 1918 rate. H. Stuart Martin, the consulting engineer, reports that the native labour supply last year was at no time sufficient to carry out the maximum scale of operations. Considerable progress is reported to have been made with development in new areas, and the reef disclosures, on the whole, were satisfactory. It is stated, however, that little has been done so far in the new area on the south side of the large South Rand dyke to give any indication of what grade of ore can be expected here, and it is not intended to extensively develop the southern area for a time, namely, until the main connecting drives to the deep-level shafts and sub-vertical shafts have been holed. Meantime the opening up of the undeveloped area in the western section is to be accelerated. The current year having opened with a fair supply of labour, it is hoped to make good progress with development work and to increase the tonnage mined. At the end of 1919 the ore reserves were estimated at 8,451,400 tons, value 6·3 dwt. over 63 in. Of this quantity 1,245,000 tons of 7·4 dwt. value were not immediately available, being required for shaft and safety pillars.

Modderfontein Deep Levels.—There was a further small increase to 507,200 tons in the quantity of ore milled at this Rand mine last year, and the working revenue, at £1,224,384, was £188,911 more than in 1918, the gold premium having contributed £113,013. Working costs were 1s. per ton higher at 18s. 5d. The net profit amounted to £604,461, as against £519,701, and the year's dividends (paid partly in scrip) were 115%, absorbing £575,000, as compared with 97½% and £487,500 for 1918. P. M. Anderson, the consulting engineer, in his annual report, states that the year's development was 1,709 ft. more than before, at 7,134 ft., and that the values disclosed were highly satisfactory. At the end of December last the ore reserves were estimated at 3,775,000 tons, assaying 9·1 dwt. over 77 in., an increase of 325,000 tons in quantity and 0·3 dwt. in value. The general manager mentions that of the ore stoped last year 91·14% was broken by machines and 8·86% by hand labour. The waste sorted was 15·5% and the recovery 96·83%.

Geduld Proprietary.—This progressive Eastern Rand mine made further headway during 1919, apart from the addition to its revenue of £77,757 by the gold premium. Nearly 4,000 tons more ore was milled than in the previous year, the total being 516,000 tons, and the working revenue was 33s. 1d. per ton (against 29s. 2d.), while working costs averaged 20s. 7d. (against 20s.), and the working profit 12s. 6d. (against 9s. 2d.) per ton. The net profit was £47,467 larger at £267,553, and the year's dividends amounted to 22½% (paid in enemy shares) against only 5% for 1918. The expenditure on capital account, exclusive of excess development, totalled £113,667, of which £75,000 was appropriated from working profits. P. M. Anderson, the consulting engineer, in his annual report, states that the total footage of development for the year was 18,444 (inclusive of 2,524 ft. of incline shaft-sinking) or 1,101 ft. more than in 1918. The ore reserves at the end of December last were estimated at 2,580,000 tons, assaying 7·4 dwt. over 61 in., or 70,000 tons more, but 0·1 dwt. less, than a year earlier.

Meyer & Charlton.—This, the star mine of the General Mining & Finance group, milled an increased quantity of ore last year (480,457 tons against 469,911 tons), but the grade was lower. The decline in average yield, however, was partly offset by a reduction in working costs (from 26s. 4d. to 24s. 6d. per ton) while the gold premium yielded nearly £46,000. The result was that the gross revenue amounted to £534,885, against £469,911 for 1918, and the gross profit was £332,367. The year's dividends (120% against 110%) absorbed £240,000, and taxes £90,500. H. Johnson, the mine manager, states that 2,087 ft. of development work was done, and the ore reserves at the end of 1919 were estimated at 516,489 tons averaging 15·5 dwt. over 55 in. Compared with the previous estimate these figures represent an increase of 11,993 tons in quantity, but a decrease of 0·34 dwt. in value.

New Goch.—Shortage of native labour adversely affected the results of this company last year, and, in addition, working expenses were inflated by the increases of white employees' pay, by a steady rise in the cost of stores, and by heavy additional levies under the Miners' Phthisis Act. However, the gold premium was a set-off against the adverse factors and enabled the company to make a net profit, whereas for 1918 it had to report a small net loss. The quantity of ore milled last year was 174,950 tons (against 197,300 tons), and working costs averaged 19s. 9d. (against 18s. 10d.) per ton. The gold premium contributed £16,989, raising the total revenue to £185,141, and the net profit was £11,894 (against a loss of £2,259). Robert Parker, the mine manager, reports that 4,713 ft. of development was done last year, and the ore reserves at the end of 1919 (based on the standard price for gold) were estimated at 97,044 tons, of an average value of 5·9 dwt. over 51 in. This quantity is equal to only slightly more than six months' supply on the basis of the tonnage mined in 1919, but assuming a gold premium of 30%, an additional 156,239 tons averaging 4 dwt. would come within the limit of payability.

Aurora West United.—At this mine there was a slight increase in the tonnage milled last year, but working costs increased by 2s. 2d. to 24s. 6d. per ton, and despite the gold premium, which yielded nearly £20,000, the net result of the year's operations was a loss of £7,966 (as against a profit of £1,933 for 1918). At the end of 1919 the accounts showed an excess of current liabilities over liquid assets of £9,652. The ore reserves were estimated at 123,384 mining tons of an average value of 5·7 dwt. over 42 in., as against 242,208 tons averaging 5·6 dwt. at the end of 1918. The management has recently been investigating the possibility of more selective mining, with a consequent considerable curtailment of operations, as an alternative to closing down the mine until more normal conditions prevail.

West Rand Consolidated.—A slightly smaller quantity of ore was milled at this mine last year (372,620 tons against 379,530 tons) and working costs rose from 21s. 8d. to 23s. 9d. per ton; these factors partially offset the benefit derived from the gold premium, which yielded £48,111. The total revenue for the past year was £503,439, and the gross profit £61,103, whereas for 1918 the gross profit was only £10,161, which was not nearly sufficient to cover debenture interest and the French fiscal tax. Allowing for these items the past year's net profit came out at £39,365. G. D. Stephen, the mine manager, states that the mine suffered from extreme shortage of native labour. Every effort was made to counteract the effect of this by the increased use of machine drills for stoping, "but in this direction it was impossible to go beyond a certain point, since the characteristics of the West Rand Consolidated are such as to make extended machine work uneconomical and expensive." In spite of the practical abandonment of sorting it was impossible to keep the mill fully supplied. This contributed to the increase in the working cost ratio; in addition, costs were inflated by expenditure on new drills, steel, and the alterations and extensions to the air and water mains necessitated by the installation of additional machines. The total footage last year was 13,153 ft., and the ore disclosed by the drives, on a stoping basis, was 171,914 tons, of which 88,357 tons, or 51·4%, indicated payable values. At the end of 1919 the ore reserves were estimated (with gold at standard price) at 1,004,963 tons averaging 6·5 dwt. over 51 in., as against 1,208,315 tons averaging 6·1 dwt. a year earlier, the reduction in tonnage being attributed to the higher level of working costs and consequent necessity for increasing the pay limit. On the basis of a 30% gold premium, however, the mine manager says an additional 409,693 tons valued at 4·4 dwt. would come within the limit of payability. With a native labour supply commensurate with the size of the property, he considers that the mine should revert to more favourable profit-earning conditions, even if the present gold premium were to disappear.

Durban Roodepoort Deep.—The past year was the twentieth of this company's career, and the financial results achieved were the worst it has ever reported, despite the fact that the gold premium contributed nearly £36,000 to the revenue. The quantity of ore treated, at 263,100 tons, was 37,350 less than in 1918, the reduction being attributed to extreme shortage of native labour and to the main hoisting-way having been hung up for repairs for two months. The yield per ton milled was 28s., as against 30s., this having been affected by a reduction in the percentage sorted, while, on the other hand, working costs were 31s. 11d., as against 28s. per ton. With gold at standard price the working loss for the year was £50,995, as compared with a working profit of £30,068 for 1918, but the gold premium reduced the loss to £15,049. Much more development was accomplished (9,205 ft. against 6,679 ft.), although work was considerably hampered by constant flooding in the deepest part of the mine, but the consulting engineer, H. Stuart Martin, points out that even last year's footage is still short of what is required to maintain the present ore reserves (estimated at 1,077,500 tons averaging 6·6 dwt.) when milling at full capacity. The tonnage stated includes 172,000 tons of shaft and boundary pillars. The development values last year have been, on the whole, quite satisfactory, the South Reef being practically payable throughout. The Main Reef is only developed in selected areas. The consulting engineer looks for "a steady and permanent improvement" when the programme of new work—the completion and equipment of the new circular deep-level shaft and the arrangements for the abandonment of the old shafts—is completed. The directors state that although, despite the premium on gold, working losses are being made, "the management believes that with the improved labour supply now available and assuming a continuation of the gold premium at about the present level, profits will be earned from April next," which would materially relieve the present financial position. Should these expectations not be realized, it will be necessary to review the financial position and the capital programme in order to determine what steps should be taken.

Roodepoort United.—At this mine a small decrease in the tonnage treated last year was accompanied by a decline in the working cost average (from 22s. 9d. to 21s. 6d. per ton), but although the gold premium yielded nearly £30,000 the net result of the year's operations was a loss of £21,530, following upon a loss of £53,129 in 1918. At the end of 1919 the accounts showed an excess of liquid assets over current liabilities of £60,966, but, on the other hand, there is a liability of £387,404 in respect of loans.

New Vaal River Diamond.—This Cape Province enterprise which leases the Vaal River estate to diggers for alluvial diamonds, reports a smaller output for 1919, despite the record high prices ruling for precious stones. The number of carats found last year was 9,793¾, as compared with 11,739¾ in 1918, but the total amount realized was £155,675 against £98,845. The company's profit was £16,470 as compared with £12,091; £18,560 was written off for depreciation of plant, machinery, investments, &c. The 5% dividend paid during 1919, absorbing £8,443, came out of the dividend equalization fund, thereby reducing this fund to £4,874.

Gurum River (Nigeria) Tin.—This company is one of the smaller Nigerian tin producers, but it is a dividend-payer. In the 12 months ended September 30 last 104 tons of concentrate was sold for a sum of £16,986; the expenditure in Nigeria was £13,306, and there were other expenses which amounted to £2,986. Consequently, the tin-production side of the business yielded very little profit, but there was a profit of £16,282 on the realization of shares and interests, and £390 was received as dividends on investments. So that the outcome of the year's operations was a profit of £17,450. The two dividends paid, of 7½% each, absorbed £17,595. An interim distribution of 7½% has been declared and paid on account of the current year. The directors state that additional areas have been acquired, and they point out that the output of tin concentrate for the first half of the current financial year amounts to 92 tons, as against 57 tons for the corresponding period of 1918-19.

Mongu (Nigeria) Tin.—There was a recovery last year in the output of this Nigerian alluvial tin-mining company, but owing to the fall in the price of the metal, the profit earned was considerably less than in the preceding twelve month. The output of tin concentrate was 552 tons (as against 476 tons in 1918 and 571 in 1917), and the amount realized was £65,136, against £119,614. The profit was £25,322, or £34,466 less than before, but the dividend rate has been maintained at 25%, equal to 2s. 6d. per share. Whereas a year ago income tax and excess profits duty were estimated to require no less than £35,000, the allowance in the latest report is £6,000. Additional areas on the tinfield have been acquired during the past year; for part of these £17,500, in fully paid Mongu shares at par (10s.), has been paid to the Anglo-Continental Mines Co. The total prospecting areas now held or applied for cover 46 square miles, and form, together with the company's mining leases, a continuous chain or group of properties.

Kaduna Syndicate.—A moderate recovery in the rate of production is recorded by the report of this company for the year ended October 31 last, 205 tons of tin concentrate having been won, against 179¾ tons in the preceding year. The output would have been greater had additional native labour been obtainable. The concentrate sold realized £181. 6s. 9d. per ton against £192. 16s. 6d. in 1917-18. The profit for the year was £17,855, an increase of £3,800. To reserve £2,435 has been added, raising this fund to £7,500, and a final dividend of 25%, less tax, making 35% for the year, is recommended, which will absorb £6,950. For 1917-18 the dividends totalled 60%, but since then the capital has been doubled, bonus shares having been issued about twelve months ago. The Syndicate has recently increased its shareholding in Kaduna Prospectors.

Kaduna Prospectors.—The report of this Nigerian alluvial tin-mining enterprise, an offshoot of the Kaduna Syndicate, contains accounts for the 13 months ended October 31 last. These show a profit of £4,422. Payment of a dividend of 30% less tax, which will absorb £1,752, is recommended. The output for the period was 58½ tons of tin concentrate, which was realized at an average price of £324 per ton of metallic tin. In the first six months of the current financial year 51 tons has been recovered.

Lahat.—While this F.M.S. tin-mining company's production was larger last year, the average price realized was considerably less and costs were higher. The quantity of tin ore sold last year was 465 tons, an increase of 67½ tons; the price realized was £150 per ton against £186 per ton. Costs were 16·12 cents per cubic yard higher. In the result the profit for the year, after providing £3,500 for depreciation, was £14,603, as compared with £29,848 for 1918, and the dividends total 2s. per share against 4s. 6d. per share. Another £3,000 has been transferred to reserve account. Since the puddler plant has been in thorough working order the mine returns have been good, and the general managers in their annual report express the opinion that the present standard of returns will be maintained during the current year.

Arizona Copper.—A much reduced working profit is reported by this Edinburgh-controlled American copper producer for the year ended September 30 last. From the company's mines 1,147,659 tons of ore was obtained during the period (as against 1,095,568 tons in the preceding year), 35,025 tons being smelting ore of an average grade of 6·45% copper, and 1,112,634 tons concentrating ore of 2·123% grade. The quantity smelted was 174,155 tons (against 216,336 tons), and the concentrators dealt with 1,111,522 tons. The production for the year was 18,237 tons of bessemer copper, of which 1,037 tons was disposed of in the form of bessemer, and 17,200 tons was refined and sold in the form of electrolytic. The whole of the stock of unsold copper, about 10,890 tons, on hand at September 30 last, has now been sold with the exception of about 250 tons, the average price realized being £26. 1s. 1d. per ton less than that for the preceding year. Cost of production has risen by over £4 per ton. The reduced price received and the increased cost together represent a reduction in profit for the year of over £30 per ton of copper produced, while, in addition, the carrying of the abnormally large stock of unsold copper entailed a heavy charge for interest. The accounts show a working profit of £108,635, which compares with £805,129 for 1918-19, and the ordinary dividend is reduced to 1s. 6d. per share, free of tax. The mines and works of the Shannon Copper Company have been acquired. The Arizona directors are now considering "a series of proposals affecting the future of the company," which is understood to mean that American interests have made an offer for the company's mines and works.